THE

# ELECTRICAL REVIEW.

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THE

**UNIVERSAL ELECTRICAL DIRECTORY**

**1900**

**Edition**

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## PROGRESS IN ELECTRIC TRACTION.

No feature of recent electric traction schemes is, perhaps, more striking than the curious alliance which has sprung up between the three-phase and direct current systems—the former for transmission, the latter for operating the motors on the cars. This combination, which is still almost a new one, was applied for the first time in this country on the Dublin Electric Tramways, the description of which was concluded in our last issue; but since that time it has been adopted in the United States on at least two important undertakings—the Buffalo Street Railways, supplied with power from Niagara Falls 20 miles away, and the New York Street Railways, the latter of which is still in course of completion, while in the United Kingdom we have seen approved for use on the Glasgow and Manchester Tramways and the Central London Railway. It is noteworthy, too, that the motor-generators which were originally installed at Blackrock have given place to transformers and rotary converters; at Buffalo rotaries were put in from the very first, although no examples of these machines of equal size were then at work, and the same thing has been done on the Central London Railway, the 900-KW. rotary converters employed for the generation—or, rather, conversion from three-phase—of the whole of the direct current required to work the line being unique in point of rated output. The fact that such important systems depend wholly upon the reliability of running and freedom from breakdown of rotary converters for their operation, is proof positive of the confidence reposed in the latter by the engineers responsible for the design of these undertakings, and cannot but be regarded as a powerful argument in favour of their use, in spite of the evidence adduced at a recent meeting of the Institution of Electrical Engineers to the effect that the Continental engineers prefer motor-generators. Where rotaries converting single-phase to direct current are in question, this preference is easily understood; single-phase rotaries have an incurable habit of sparking, their safe load is roughly about half that of a polyphase rotary of the same size, they are far less efficient, and they cannot be started on the A.C. side; but where the supply is on a polyphase system, the respective merits of motor-generators and rotary converters are more nearly balanced. The final decision between them cannot be attained by reasoning; it must be settled by the results of practical experience with both systems.

On the other hand, it must not be forgotten that transmission by polyphase currents is by no means essential, where the distances are not excessive; direct current transformers have been brought to such a degree of perfection within recent years, that transmission by direct current at high pressures is now quite feasible. The most notable example of such of which we are aware is that which was put in operation a few months ago, on what we may be allowed to call "our own British railway"—the City and South

London. There Mr. McMahon has boldly adopted the three-wire system, with 1,000 volts between the outers, while by means of boosters, adding 500 volts to each side of the system, a total pressure of 2,000 volts is obtained for transmission to a remote sub-station. If 2,000, why not 4,000 volts? The difficulty is only a matter of degree, and it must be borne in mind that, *cæteris paribus*, the direct current system is content with one-half the amount of copper in the line that is required by any alternate current system whatever. The success which has already attended this new departure is a favourable augury of future developments in direct current transmission, and the progress of the undertaking will be watched with keen interest by all power engineers.

Finally, there is a third system of traction, one of which we have as yet no instance in this country—namely, the direct application of the three-phase supply to the motors on the cars. The remarkable success of this system on the Continent, where it is well established, leads us to the conclusion that the grave objections which have been raised against the use of three-phase motors and a double trolley wire are somewhat exaggerated, and that there are conditions under which the system may be even preferable to direct current working. The constancy of speed of the cars, the simplicity of the transforming apparatus, and the total absence of electrolytic troubles, are powerful arguments in its favour, while the readiness with which it is possible to return power to the line when descending steep gradients is also a valuable feature. On the other hand, as Mr. Parshall pointed out in reply to the discussion on his paper on the Dublin-Dalkey Tramway before the Institution of Civil Engineers, the drop in the rails is increased by their inductance, the double trolley is unsightly, the magnetic blow-out controller is inapplicable, and the induction motor does not lend itself to series parallel working—the last a serious drawback. On the whole, we do not consider it in the least likely that three-phase traction will obtain a foothold in this country for many years, unless great advances are made beyond present practice.

Conduit and surface contact systems appear to be at a standstill, and the same is true of accumulator traction. Hardly a week has elapsed since the Birmingham Corporation abandoned its long continued opposition to the trolley wire, and gave consent to the Tramways Company to instal the overhead system on the Bristol Road section. The eagerness of the company to drop the battery system may be judged by the fact that it has undertaken to erect the whole of the equipment, and to remove all the overhead gear at the expiration of its lease in 1911 at its own expense, unless the Corporation should think fit to buy it at a valuation. The Corporation is apparently undecided whether to adopt the overhead or the underground system when the lease falls in; but it is agreed that the rolling stock and the underground feeders, which are suitable for either system, shall be bought over in any case.

For ourselves, we have no doubt as to the result; the trolley wire will triumph, and we shall shortly see Birmingham following the example of all our leading cities, except London, which is not up-to-date, viz, by installing electric tramways as widely and as quickly as possible.

Alas! that London should linger in the rear! Not only are new modes of travel resisted to the uttermost, but even old-established means of transit are crushed out of existence by official incompetence and greed and by the lack of enterprise on the part of the undertakers. Even the steamboat service on the Thames has gone!

However, we have our electric railways, existing and prospective, and there are favourable indications of future developments in surface tramways. The Metropolitan railways, sluggishly it may be, are yet making progress towards the inevitable adoption of electrical propulsion. Why should we not see a speedy, comfortable, and frequent service of electric launches on the Thames, to complete the list of improvements in transit facilities, with which, we hope, the new century will be inaugurated? Accumulator traction is at its best when applied to the propulsion of boats—a vastly different thing from the running of tramcars—and it is entirely free from the nuisances of smoke and heat, vibration, &c., with which the present system is handicapped. To be profitable, the service must be made popular, while at the same time the cost of working must be small. The relative working costs of a score of steamboats, each carrying at least one stoker and one engineer, and burning coal *ad lib.*, and those of a similar number of electric launches, supplied with energy from a single generating station working under the most economical conditions of load and management, cannot fail to be in favour of the latter, while all the other advantages of electric propulsion are thrown in. Now is the time; in a few months it may be too late. We earnestly invite the attention of financiers and engineers to this unique opportunity.

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A Telephone Experiment.

M. E. Pievard published in the February *Bulletin de la Société Belge d'électriciens*, an account of an interesting telephonic experiment depending upon contact electrification or the Volta effect. His attention was directed to an observation by M. Banneux, director of the telegraph service, that musical sounds can be transmitted through a telephone circuit, using for a transmitter a diaphragm making intermittent contact with a fixed stud, and without any battery. That the action was purely electrical, was shown by allowing the two wires of the circuit to touch, when all sound in the receiver ceased. A number of expertments were tried to ascertain the most favourable conditions for the experiment, and the best results were obtained with a German-silver diaphragm with a large contact piece of platinum soldered to it, when an induction coil was inserted in the circuit having a low resistance primary, and a secondary of the same resistance as the receiver. The action was traced to the electromotive force of contact between the platinum and the German-silver. The movement of the diaphragm serving to alternately diminish and increase the capacity of the primary circuit, in the same way as is done by lifting one of the plates in the ordinary Volta experiment. The explanation was corroborated by an experiment in which a toothed wheel of copper was rotated on a steel axle. One of the copper wires from the telephone circuit was held against the teeth of the wheel so as to make an intermittent contact. Then if the other copper lead from the primary circuit was held against the steel axle, the passage of each tooth was heard in the telephone receiver. If, however, it was held against the side of the copper disc, nothing was heard. While the experiment is curious and interesting, the explanation does not seem quite satisfactory, since on the ordinary view of the action of the Volta effect, the action should be more marked with a small contact piece on the German-silver diaphragm than with a large one, whereas, the reverse is the case. In the wheel experiment, the changes of capacity between the copper leading wire and the iron spindle of the wheel in the successive positions of the teeth are so exceedingly minute that an appreciable action due to a Volta effect could hardly be expected. The effect appears to be worth further examination.

# THE NEW TELEGRAPH STEAMER "VON PODBIELSKI."

By Prof. JAMIESON, M.Inst C.E., F.R S E.

(*Continued from page* 729.)

## Main Boilers and Engines.

Steam of 180 lbs. working pressure is supplied from two large single-ended boilers of the marine type, each of 15 feet 9 inches diameter and 10 feet 9 inches long, having three Deighton's patent furnaces and separate funnels. A large Cochrane's patent donkey boiler supplies the requisite steam to the auxiliary machinery when the vessel is in port. The boilers are fed with fresh water through a Davie's feed filter and evaporator by Weir's feed pumps and feed water heaters.

The propelling machinery consists of twin sets of triple-expansion surface condensing vertical engines having cylinders 17, 26½, and 47 inches diameter by 33 inches stroke. Each of the main engines is fitted with an Edwards' air-pump and a separate centrifugal pump for circulating sea-water through the surface condensers.

The engine room is cool and open, being without any division between the port and starboard engines, although separated from the boiler room by a watertight bulkhead. Two separate tunnels lead along the shafting to the stern tubes. The propellers consist of cast-iron bosses with four bronze blades bolted to each. The engines are very easily stopped and started, and, moreover, they possess the desirable quality of smooth, slow working so necessary when grappling for cables, or when the ship has to be kept steadily in position during the operations of testing, jointing and splicing.

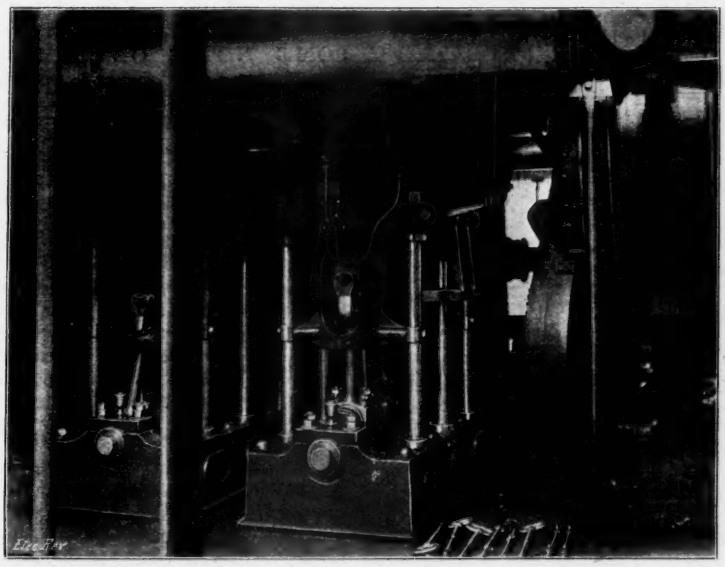

Fig. 6.—The Forward Picking-up and Paying-out Plant of the Cable Steamer "Von Podbielski."

## Auxiliary Steam Machinery.

Beginning at the bows and going aft, we find that the outfit of the steamer includes Emerson, Walker and Thomson's patent steam capstan windlass, two separate engines for working Johnson & Phillips forward picking-up and paying-out gear and another engine for their after paying-out machine, steam winches at each of the mast derricks, Alley and McLellan's "Sentinel" steam steering gear (which will be described later on), and Brotherhood's three-cylinder engines for working the small cable turning-over gear, and Kelvin's sounding machines.

## Steam Steering Gear.

The safety and ease with which steamers are guided, greatly depends upon the efficiency, readiness of action, and durability of the steam steering gear. In telegraph steamers this is more especially the case, since they have so frequently to be stopped, started and manipulated at very low speeds in proximity to cable buoys and under other delicate circumstances when on the cable ground. The following perspective view gives a good illustration of the steering gear fitted on board the *Von Podbielski*, and from the long and varied experience of the makers of this class of machinery, as well as the number of ships which they have fitted with their steering plant, it will be seen that no novel experiment is being tried. Of course, when the steamer is supplied with twin screws as this one is, there is an additional power factor at command, for readily and rapidly turning the vessel. Nevertheless, the steering gear should act as quickly as possible, and in perfect synchronism with the turning of the quartermaster's wheel, without hunting or over-running.

The vertical spindle (shown on the upper right hand of the figure) is connected directly to the small hand-steering wheel situated in the steering house. When this spindle is turned to the right or left, it moves the lever up or down, which is jointed to the rod of the central piston controlling reversing valve. This valve admits steam to the slide valve casings, which passes therefrom to the front or the back of either cylinder as may be desired, for turning the horizontal chain barrel in a right or left-handed direction, so as to move the ship's rudder to port or starboard. The crankshaft worm and the wheel with which it gears, as well as the small pinion on the above-mentioned vertical spindle, are thoroughly well lubricated by working in an oil bath.

## Electric Lighting Plant.

This consists of Messrs. Harvie & Co.'s two-pole compound wound self-regulating dynamo, coupled direct to a Shank's steam engine. At 300 revolutions per minute, this steam dynamo plant has an output of 230 amperes at 65 volts, and supplies current to 179 incandescent lamps, distributed throughout the ship in the most appropriate manner. It also delivers about 60 amperes to one of Harvie's 20-inch Admiralty type of parallel ray searchlight projectors, which is situated on the top of the chart house. A 12-inch electric fan, fixed in the after end of the saloon, is also worked by current from the same dynamo, to enable this part of the ship to be kept cool and fresh. A polished marble switchboard, having the necessary switches, fuses, ammeter, and voltmeter, is duly connected to the dynamo and to the various lamps on the two-wire distribution-box system. No deflection of any of the compasses is observable when the lighting current is turned on or off in any part of the ship, although the search-light apparatus and its connecting wires are nearer to the standard Kelvin compass than would seem advisable without the forward and return conductors being twisted together.

A complete service of electric bells has been fitted up in connection with the saloon cabins by the same Glasgow firm.

## Testing Room.

This most important apartment is well situated, being nearly amidships, and between the main and spar decks. It is sufficiently commodious to contain all the necessary instruments without overcrowding. The whole of the apparatus has been supplied by Messrs. Johnson & Phillips. The testing table is placed athwart ships, and has an upward and forward slope, whilst the table for the speaking instruments is at right angles to the former, and on the port side opposite to the entrance door. The spaces under these tables are occupied by drawers and sliding-door lockers for storing spare instruments, tools, instrument cases, &c.

The testing and speaking batteries are placed upon racks

in open shelves on the after side of the testing room, where they can be readily examined and dried, thus avoiding the bad plan of stowing them away in dark inaccessible corners or cupboards. Practical sea-going electricians can appreciate the attention to such apparently minor details better than those on shore, as these tend to the prevention of hitches and consequent waste of valuable time, during the anxious moments when testing the cable as it hangs from the bows.

Both of the Sullivan galvanometers for taking insulation and copper resistances, as well as capacity, are of the latest and most approved "Universal" type, which, it may be remarked, have now replaced the time-honoured "Thomson marine ironclad galvanometer" in all the most recent outfits of cable steamers. The sensitiveness and periods of these galvanometers have been so arranged as to facilitate the taking of copper resistance by the Wheatstone method and insulation resistance by direct deflection in the shortest time. They are remarkably dead beat, and the zero is not altered by any movements of the ship or by local magnetic influences, but I was somewhat surprised to see the old-fashioned scales with their paraffin oil lamps, instead of transparent scales and electric lights. The only excuse that I received was, that these oil lamps kept the room warmer than the electric light!

For reversing the direction of the current through the galvanometers, the Rymer-Jones key is adopted. It is worth noting that the principle of this admirable key has been followed in the case of subsequent testing keys and reversers brought before the public by others.

Sullivan's "Universal" shunt boxes are used in connection with each of the testing galvanometers. Apart from their appreciated value as shunts, these appliances can also be used instead of the Thomson-Varley slides, or as standard resistances of 100,000 ohms, or as the proportional parts of a Wheatstone bridge, and also as high resistances in the fall of potential method for localising faults. All of these adaptations are particularly handy in the exigencies of testing work on board ship, where compactness of apparatus is so great a desideratum. Another advantage of this shunt box is, that it is wound with manganin wire, the temperature coefficient of which is practically *nil*, so that for the most exact observations, no temperature correction need be applied. The details in this shunt box have been carefully thought out, and it seems to be as popular now, as the "Universal" galvanometer itself. All the instruments on board, from the galvanometers and shunts downwards, are of the latest pattern and best construction. It may be added that only smooth stoned and unpolished ebonite, according to the Post Office practice, has been employed. The speaking instruments are of the ordinary Morse and mirror types, and, therefore, call for no special remarks.

I did not, however, observe a complete set of speaking tubes or loud-speaking telephones and call bells between the testing room and the navigating bridge, the tanks, bow-sheaves, and the main engine room. These are very useful, and enable this most important department to be placed in direct communication with the various other sections, so as to take and give directions with the least possible fuss, when the saving of a few minutes often mean the saving of much vexation and money. In fact, all the departments of the chief cable engineer, electrician, navigators, and the main engine room should have instant communication with each other by the most direct and approved methods.

### The Cable Machinery.

As already mentioned, this vessel is fitted with the latest and best types of cable machinery by Messrs. Johnson and Phillips, of the Victoria Works, Old Charlton, London, under contract with Messrs. David Dunlop & Co., of Port Glasgow. The equipment comprises a double forward combined picking-up and paying-out plant, and an after paying-out machine, together with all the necessary bow and stern sheaves, dynamometers, and leads.

### Forward Plant.

As will be seen from the figure on the previous page, the double picking-up and paying-out gear is erected on the main deck, and so bound together by three strong steel frames fixed between the main and spar decks, that the machines are side by side. They are driven by two independent pairs of engines, so that either or both sets of engines can drive either or both machines. These two sets of engines thus enable the two machines to be worked simultaneously in reverse directions, so that one side could be picking up whilst the other is paying out; and, again, one pair could always be available in case of a breakdown to the other. For ordinary work, one pair of engines will be sufficiently powerful, whilst the two pairs can be used together for heavy loads. Each machine is arranged for two speeds and powers; the picking-up machine for a lift of 25 tons at 1 knot, or 10 tons at $2\frac{1}{2}$ knots, and the paying-out machine for 10 tons at $2\frac{1}{2}$ knots, or $6\frac{1}{4}$ tons at 4 nauts per hour.

The engines have cylinders 8 inches and 8 inches diameter by 8 inches stroke, and are each capable of developing 100 B.H.P. at 300 revolutions per minute when supplied with steam at 150 lbs. per square inch.

The crankshafts of the engines lie parallel to the centre line of the ship, and are geared to the first motion shaft by means of double helical bevel wheels. When it is desired to take one engine out of gear, its bevel wheel is drawn along the crankshaft by means of a large screw nut, which is concentric with the shaft and works on a screwed shoulder. This nut is turned by means of a bar-lever, and the former serves to take the thrust when the machine is working.

*(To be continued.)*

## SOME NOTES ON THE ELECTRICAL EXHIBITS AT THE PARIS EXHIBITION.

By E. KILBURN SCOTT, A.M.I.C.E.

*(Concluded from page 749.)*

### Hungary.

Mainly with the help of Messrs. Ganz & Co., Hungary has sent a very good show. The writer particularly noticed a large Ganz three-phase alternator mounted on the crankshaft of a Lenz-Steuering patent horizontal slow-running engine. The difficulty of finding space for the pole bolts is got over by having double arms to the fly-wheel, thus leaving a clear space for the bolts in between. The exciter is driven direct by an arm engaging with an extension of the crank-pin, some play being allowed for, so that the centre line of the exciter shaft need not be dead true with the engine crankshaft. The valve gear, &c., of this engine is worthy of attention, the governors being fixed on the cross shafts and actuating moving eccentrics direct. The makers are Este Brunner Maschinenfabrik Gesellschaft Brünn, Hungary.

Ganz & Co. have an exhibit of early dynamos, alternators, &c., and they also show some neatly designed house transformers which are constructed with two large discs, so that they can be rolled about without injury.

Of course, there are many other Austrian and Hungarian exhibits, a large vertical engine, by Ringhoffer, of Prague, driving a Siemens-Halske dynamo, being especially noticeable.

The firm of Kolben & Co., of Prague, have several imposing machines in various parts of the building.

### France.

Practically all the French firms are exhibiting, and there are many large generating sets. Amongst the most noticeable are:—A Farcot horizontal engine with inductor alternator divisible midway in a plane with the fly-wheel.

A Dujardin Lille horizontal cross compound engine and a three-phase alternator, by Schneider & Co.

Horizontal engine, by E. Garnier and Faure Braulieu, with Postal-Vinay multipolar dynamo.

A Delaunay, Belleville & Co.'s high speed enclosed engine coupled to a Breguet compound alternator, constructed on the system Boucherot. The output of this set is 736 KW., 2,200 volts, 50 periods, 250 revolutions.

The Etablissements Cail have a large vertical cross-compound engine, with 1,000-KW. alternator supplied by the French Thomson-Houston Company. Carels Freres show a horizontal engine with Kolben three-phase alternator on crankshaft.

The Compagnie Générale d'Electricité de Creil, in conjunction with Etablissement Weyher et Richemond, exhibit a steam dynamo having an output of 2,750 amperes at 250 volts; speed, 120 revolutions per minute. The dynamo has 14 poles, and its armature is 90 inches diameter by 20 inches long, and commutator 24 inches diameter by 7½ inches long, with 56 combined copper and carbon brushes.

These sets besides others will be shown working, as the whole of the motive power necessary for driving machinery in the buildings on the Champ de Mars is distributed by electricity, one half being supplied by French contractors and the other half by contractors of various foreign nations. The majority of the motors are three-phase.

### Switzerland.

As was to be expected, the Sulzer engines are a feature of the Swiss exhibit. One of their horizontal engines is coupled to a Brown-Boveri three-phase machine, having the armature yoke arranged for turning round for cleaning, &c. Another engine is coupled to a three-phase machine by J. J. Rieter & Co., the fly-wheel and poles being constructed on the lines of the Niagara machines—that is, so that the magnetic pull opposes centrifrugal force. See fig. 4.

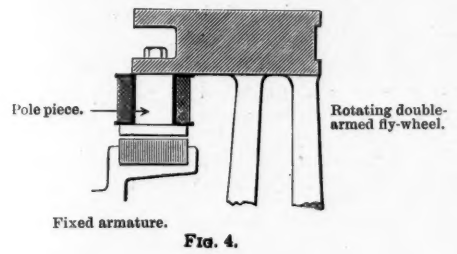


Fig. 4.

This firm also show a curiously constructed motor, of which fig. 5 is a rough sketch. The stator or magnet system has the poles projecting over a single exciting coil, as used to be

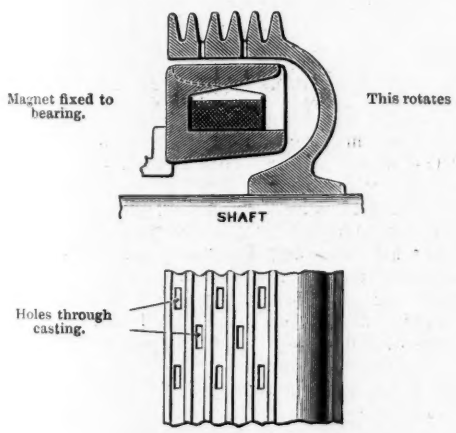


Fig. 5.

the fashion with alternators, whilst the rotor consists of a plain casting keyed to the shaft, and having holes—alternately two and three in a row—cut through the bottom of the rope grooves.

There are many exhibits of turbines by Escher, Wyss and Co., Theodore Bell, and Pickard, Pietet & Co., this last firm showing a turbine coupled to an Oerlikon three-phase alternator of 750 H.P.

Some very neatly designed high-speed engines are shown by Emile Mertz, of Basle, and small horizontal engines are to be seen at the stall of Ateliers de Construction, Burckhardt Basle. Escher, Wyss & Co. also exhibit engines, and Theodore Bell general machinery, amongst other items being a large motor-driven saw with double screw feed.

### Belgium.

The principal feature of the Belgian exhibit is the enormous horizontal gas engine by Cockerill, of Seraing, the excessive proportions of some of the parts making it look strange to eyes accustomed to the usual steam engine practice.

This engine is one of the two largest gas engines in the world, and is intended for blowing; it works with ordinary blast furnace gas, that is to say, the gases do not undergo any special process of purification or cleaning. Built on Delamare-Debouteville and Cockerill's patent, with a single cylinder, it develops over 600 H.P. at 80 revolutions per minute. It is designed to supply 500 cubic metres (17,500 cubic feet) of air per minute at a pressure of 40 cm. of mercury (7½ lbs. per square inch), this sufficing for a daily production of 150 tons of Bessemer hematite pig.

The dimensions of the cylinders are—

| | | |
|---|---|---|
| Diameter of gas cylinder | ... | 1,300 mm. (51"). |
| " " wind " | ... | 1,700 mm. (67"). |
| Stroke of piston ... | ... | 1,400 mm. (55"). |

An exactly similar engine to the one exhibited has been in regular work at the works of the John Cockerill Co., Seraing, since November, 1899, having taken the place of the steam blowing engine. On March 20th and 21st of this year this engine was subjected to a thorough brake test, the blowing cylinder being temporarily disconnected. With gas having a value of 800 to 900 calories (90 to 100 B.T.U. per cubic foot), the consumption when developing 600 H.P. was 3¼ cubic metres (115 cubic feet) per B.H.P.-hour. Tested as a blowing engine, it was found that when run for three hours at 84 revolutions per minute, a steady wind pressure of 40 cm. of mercury (7½ lbs. per square inch) was obtained. At 94 revolutions per minute and slightly different quality of gas, the wind pressure rose to 45 cm. of mercury (8½ lbs. per square inch). Finally the engine was run at the high pressure of 62 cm. of mercury (11½ lbs. per square inch), the speed being reduced to 62 revolutions per minute.

The trials were a complete success, and in view of the developments in power transmission on a large scale from our coal fields, electrical engineers would do well to watch this most interesting and bold departure in gas engine practice. As a matter of fact, a 200-H.P. single cylinder gas engine of somewhat similar construction has been in use for more than two years at the Cockerill works driving the electric generators used for the electric power transmission.

The Compagnie International d'Electricité, Liège, have a large and interesting exhibit. Machines by Peipier are also shown.

### Italy.

Franco Tosi, of Legnano, has three engines of 1,200, 800, and 60 H.P. respectively, coupled to dynamos by Schuckert, Societa Esercizio Bacini, and Ansaldo & Co., of Genoa.

### United States.

The bulk of the United States machinery exhibit will be out at Vincennes, but there is a beautifully decorated pavilion in the gallery of the Electricity Hall, in which are shown original apparatus, first Brush and Jandus lamps, early Thomson-Houston dynamos, instruments, &c.

The Batcheller Pneumatic Tube Company, of New York, have a working exhibit.

Many American exhibitors have sustained severe loss through the disappearance of the ss. *Pauillac*, which had on board, amongst other machinery, the power plant for the supplementary exhibit out at Vincennes. For this latter a Willans and Crompton set has fortunately been obtained, and another Bullock generator to replace the one that was lost is on its way, to be coupled to a Ball engine.

It may be mentioned that Vincennes is 6 miles from the Champ de Mars; the pleasantest way of getting there is by steamboat, the round trip occupying about 2½ hours.

### Cranes.

A striking feature of each half of the electricity building is an immense travelling crane. That in the French section is of the double cantilever type, built by Jules le Blanc, of Paris, and that in the foreign section is of girder pattern, built by Carl Flohr, of Berlin. They are both carried

direct from the ground, and are, of course, electrically-driven throughout.

In the Hungarian section there is an electrically-driven overhead traveller, each of the crabs being fitted with two three-phase motors, working through worm gears.

The above-named firm, Jules le Blanc, have installed five of the "Rampes mobiles" or moving staircases, of which there are 27 altogether, the Etablissement Cail and Maison Piat being responsible for the remainder. The incline is one in three, and speed 37 feet vertical rise per minute. In each case continuous current motors are used.

## THE TELEPHONING OF LONDON BY THE POST OFFICE.

As the Post Office is about to commence laying the underground mains in connection with the Government scheme for the telephoning of London, it may be of interest to give at this stage a few particulars of the area to be served and the exchanges to be established, together with some preliminary notes on the subject of the cables to be employed, the conduits and manholes to be constructed, and the switchboards and the method of working to be adopted.

### Area.

The general scheme having already been described in the daily press, it will suffice to indicate briefly the scope of the undertaking. The area to be served is that known as the "London Telephone Area," which, to all intents and purposes, is that at present served by the National Telephone Company. It extends from Reigate nothwards to Waltham Abbey, and from Romford westward to Harrow, and embraces about 600 square miles. It would, of course, be impossible to carry out the work in all parts of this extensive area simultaneously, for even if there were an available staff, manufacturers could not produce with sufficient rapidity the required stores and apparatus. The Post Office has therefore decided to split up the work into what may be called sub-areas. The sub-areas in which work will commence this month are those for the Embankment, Westminster, and Kensington, to be followed immediately by the City work, and a little later by work in Hammersmith, Wimbledon, Putney, and so westwards to Kingston and Twickenham. When the work in these sub-areas has sufficiently advanced, the sub-areas in other districts will be taken in hand. But the work, which will be for the most part underground, is of such a difficult character, especially in the City, that the progress may be to the uninitiated appear slow.

### Exchanges.

The Central Exchange will be located in a portion of the premises in Queen Victoria Street presently used by the Post Office for Savings Bank business and the completion of this Exchange is promised within a year. Almost simultaneously with the opening of the Central Exchange, sub-exchanges will be opened at Westminster, Kensington, Wimbledon, Putney, Richmond, Chiswick, Kingston, and Twickenham.

As the work progresses in other districts, sub-exchanges will be opened at about similar distances apart, the nearest to the City in the various directions being probably about Marylebone in the north-west, Islington in the north, Stratford in the north-east, Stepney eastwards, Deptford south-east and in the vicinity of the Elephant and Castle, southwards. With a scheme of sub-exchanges carried out on the lines indicated an excellent service at a moderate rental should result.

### Cables.

The cables to be employed are paper-insulated and lead-sheathed. The advantages which dry-core cables (as cables with paper insulation are called) possess over the ordinary gutta-percha and india-rubber insulated cables are low capacity, high insulation, small electrification, and great compactness. For subscribers' lines the conductor will weigh 20 lbs. per mile, the mean diameter being 35·5 mils, and the maximum resistance 43 89 ohms per mile; whilst the conductor of the cables for junction lines will weigh 40 lbs. per mile, with a mean diameter of 50 mils and a maximum resistance of 21 94 ohms per mile. For subscribers' circuits on main lines the largest cable to be used will contain 217 pairs, and the largest size for junction lines will consist of 108 pairs.

The following table gives some useful data as to the various sizes of the two classes of cables to be employed on this telephone work:—

Table I.

| | 20-lb. conductor. | | | 40-lb. conductor. | | |
|---|---|---|---|---|---|---|
| No. of pairs. | Mean thickness of lead. | Maximum external diameter. | Average weight per mile. | Mean thickness of lead. | Maximum external diameter. | Average weight per mile. |
| | Inches. | Inches. | Tons. | Inches. | Inches. | Tons. |
| 7 | ·110 | ·700 | 2·48 | ·115 | ·880 | 3·57 |
| 12 | ·115 | ·900 | 3·62 | ·130 | 1·150 | 5·36 |
| 19 | ·130 | 1·060 | 4·78 | ·140 | 1·350 | 7·00 |
| 27 | ·130 | 1·250 | 5 90 | ·140 | 1·600 | 8 63 |
| 37 | ·140 | 1·350 | 6·98 | ·140 | 1 750 | 9 82 |
| 48 | ·140 | 1 550 | 8·24 | ·150 | 2 050 | 12 47 |
| 61 | ·140 | 1 650 | 9 03 | ·150 | 2·200 | 13 85 |
| 75 | ·150 | 1 850 | 10 92 | ·160 | 2 450 | 16·60 |
| 91 | ·150 | 1·900 | 11·54 | ·160 | 2·600 | 18·16 |
| 108 | ·150 | 2 100 | 13·00 | ·175 | 2 850 | 21·50 |
| 217 | ·160 | 2 650 | 19 19 | ... | ... | ... |

The paper used for covering the 20-lb. conductor averages ½ inch in width and for the 40-lb. wire ¾ inch, the thickness of paper in both cases being about 5 mils. The paper is usually laid on longitudinally with a slight overlap, to prevent contact between neighbouring wires, and is tied spirally with thin string. The wires are laid up in pairs uniformly

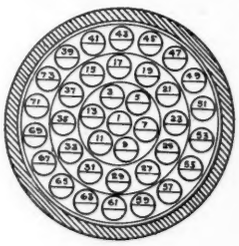

Fig. 1.

twisted together, the length of the complete twist being 4 inches for the smaller conductor cable and 6 inches for the larger. One wire of a pair is covered with white paper and the other wire with coloured paper, usually red, as a means of distinguishing the wires for jointing purposes. Between each layer there is a spiral wrapping of paper (usually 5 mils. thick) and a final wrapping of similar paper is added between the outside layer and the lead sheath.

The following table shows how pairs are stranded together to form any size of cable; and figs. 1 and 2 represent a section of a 37 and a 48-pair cable respectively:—

Table II.

| No. of pairs in cable. | Number of pairs of wire. | | | | | |
|---|---|---|---|---|---|---|
| | Centre. | First layer. | Second layer. | Third layer. | Fourth layer. | Fifth layer. |
| 7 | 1 | 6 | | | | |
| 12 | 3 | 9 | | | | |
| 19 | 1 | 6 | 12 | | | |
| 27 | 3 | 9 | 15 | | | |
| 37 | 1 | 6 | 12 | 18 | | |
| 48 | 3 | 9 | 15 | 21 | | |
| 61 | 1 | 6 | 12 | 18 | 24 | |
| 75 | 3 | 9 | 15 | 21 | 27 | |
| 91 | 1 | 6 | 12 | 18 | 24 | 30 |
| 108 | 3 | 9 | 15 | 21 | 27 | 33 |

When the stranding has been completed the "core" is thoroughly dried at a temperature not exceeding 225° F. In some cable factories this is done by placing the iron drum, on which the completed core has been wound, in a

hot-air chamber which is kept at a uniform temperature of about 225° F. The time taken to dry the paper by this process varies from three to six days, according to the size of the cable and the amount of moisture in the substance of the paper. In other factories the core is placed in an iron

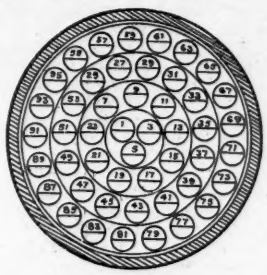

Fig. 2.

cylinder and dried under vacuum, and by this method the drying can be done in about one-third the time required by the ordinary oven process.

After the core has been dried it is lead sheathed, molten lead at a temperature of not less than 600° F. being forced on round the core under a hydraulic pressure of from 2 to 3 tons to the square inch.

The completed cable is put in a tank of water, where it remains for 24 consecutive hours, in order to prove the sheath, and the cable is thereafter subjected to electrical tests for electrostatic capacity, insulation, and conductor resistance.

In the case of both the 20-lb. and the 40-lb. conductor cables, the mean electrostatic capacity of each wire, measured against all the remaining wires of the cable and the lead sheath to *earth* is ·08 microfarad per mile; and the mean wire to wire capacity of each pair, all the remaining wires in the cable, and the testing battery and apparatus being *insulated*, must not exceed 70 per cent. of the mean wire to earth capacity. This low capacity is mainly due to the large amount of air space in dry-core cables, averaging about 60 per cent. of the entire internal space. Indeed, provided the paper used has a low specific inductive capacity and has been thoroughly dried, the capacity may be very accurately gauged by the amount of air space in the cable, and this, of course, is regulated by the width and thickness of the paper.

The insulation resistance of each wire in any cable from every other wire in the cable and from the lead sheathing, all of which are to earth, must not be less than 10,000 megohms per mile after one minute's electrification at a temperature of not less than 50° F., the electrification during the test to be steady. The voltage for this test may be 600, but that usually employed is 450.

### Conduits.

Hitherto the Post Office has confined itself in underground conduits to the use of cast-iron pipes, but till now

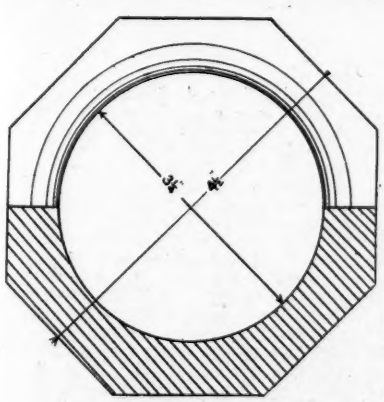

Fig. 3.

the Post Office has never had to lay more than about half a dozen conduits in any one trench. However, this big scheme of telephoning London by means of underground wires brings about an entirely new condition of things. Under this scheme 50 conduits in one trench will be quite common in the City, and in special cases this number will be much exceeded. In such quantities 3-inch cast-iron pipes require a large amount of space, and space, even underground, is very limited in London. The Post Office has, therefore, resorted to glazed earthenware ducts in place of cast-iron pipes where the number of conduits exceeds six. An end elevation, showing half section, of the form of duct to be employed is shown in fig. 3, which also gives the sectional dimensions of the duct. It is made in two lengths, namely, 18 and 24 inches, the shorter duct being used only where the conduits enter manholes for the purpose of breaking joint.

*(To be continued.)*

## THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers, held at the Institution of Mechanical Engineers on Thursday evening, May 3rd, a paper was read by Mr. H. M. Sayers on the "Calculation of Distributing Systems of Electric Traction Under British Conditions."

The discussion thereon was opened by Prof. Andrew Jamieson, who regarded the paper as one which contained a great deal of sound matter requiring special study. He referred to his visit to Cape Town in connection with the tramways there, and stated he found no less than 30 volts between the end of the lines and the power house. The result was electrolytic troubles and disturbance on the submarine cables. He advocated the use of boosters. Owing to the extraordinary character of the slate formation, forming a basin in which Cape Town lay, the rails returned only about 70 per cent. of the current, and 30 per cent. went out to sea.

Mr. Taylor spoke of the paper as being a thoroughly practical one, discussing in detail the advantages from a distribution standpoint of the single and double station and the polyphase system. He had applied some of the calculations to light railways. Advocates of high tension transmission might try to reduce the costs of that method, but even supposing that those items most readily dealt with were halved, it would reduce ·352d. to ·292d. only. Mr. Sayers had taken a case rather in favour of polyphase transmission, as he assumed 28½ miles of track, 57 cars, and a heavy car mileage per annum. Attendance at the sub-stations reckoned at 3s. per week each seemed distinctly low and rather in favour of polyphase. The high losses were due to transformers. Mr. Taylor then showed how the cost was affected by frequency of service, and discussed whether the question of distance of transmission did or did not depend upon the distribution of traffic. He dealt with the arrangement of boosting described in the paper, which only appeared to allow for boosting on the portion of the length of trolley line supplied, and not also on the feeder line to the section fed by it.

Mr. Eustace Thomas took up the question of most economical distribution, and gave, as his opinion, that generally the systems put down had regard to first cost rather than economy. It perhaps seemed absurd to talk of another way of putting Kelvin's law, but it was apparently more accurate than the ordinary mode of expression. Take out the cost of one mile of cable; if any given size be taken, it is a question whether it would not be better to have a larger size. Let the resistances of the cables be $R_1$ and $R_2$, then the power wasted in each would be $R_1 K_1$ and $R_2 K_1$, while the interest, &c., charges would be $P_1 K_2$ and $P_2 K_2$, and to get the best result,

$$(R_1 - R_2) K_1 = (P_2 - P_1) K_2$$

or

$$\frac{R_1 - R_2}{P_2 - P_1} = \frac{K_2}{K_1}$$

where $\frac{K_2}{K_1}$ depends only on the system adopted, and not on

the size of the cables. For a given case he had worked out, the figures were :—

$\frac{12}{16}$ 406
$\frac{12}{14}$ 624
$\frac{12}{12}$ 1,130
$\frac{12}{13}$

$$\frac{K_2}{K_1} = \frac{c^2 \times \text{hours per day and cost of extra unit from station}}{\text{Percentage rate of interest, maintenance and depreciation.}}$$

and the result gave 616, showing that about $\frac{12}{13}$ was the most economical size.

Mr. Jenkin pointed out that the paper did not compare the one and two station, and the polyphase systems of supplying tramways; interesting as it was, the matter could not be generalised. He thought feeders should be run to separate sections of line, and two cars might connect the feeders at different parts of the line.

Mr. E. K. Scott thought the polyphase system would have shown better if taken at 5,000 volts instead of 2,500 volts. No attention at the sub-station would be required if the polyphase system were assumed to be used directly on the cars.

Mr. Swinburne had always some fear in discussing such a paper, but he regarded the risk of a departure from accuracy to get simplicity as very real. Under actual circumstances, insulation comes in; this does not vary as the cost of copper, and Kelvin's law in its simple form does not apply. Another element was the eating of pipes that were "not ours," the private individual could not do so, but he supposed tramways could eat pipes as much as they liked provided they followed the Board of Trade regulations. Seriously, the corrosion of pipes, he was afraid, would be most serious. He thought the three-wire system had not been sufficiently considered, but the present Board of Trade Rules will not fit three-wire systems. He supposed the reason why this method had been overlooked was that some American had said they did not do such things in America. He wished to state that the booster system is perfectly applicable to the three-wire system, and the bigger the system is the easier it would be to manage. Finally, the way out of the difficulty would be to put a booster on pipes.

Mr. E. T. Carter asked if the three-wire system was not in use on the City and South London Railway, and Mr. McMahon said it was, and the balancing was effected by battery and sub-station and balancers.

Mr. R. C. Quin differed from Mr. Sayers as to a drawing-in system for cables. He had used both, and concluded that if you draw in you will have to draw out, whereas if laid solid, or buried, not only is cheapness gained, but no necessity will arise for removal. He, as a municipal and tramway engineer, preferred granite setts between tramlines, because the traffic was always heaviest on the crown of the road, and the granite setts tended to keep down the excessive wear. He regarded reliability as worth something more than a few pounds, and with all transformer systems there was something to break down.

Major-General Webber compared tramway and telegraph pole-fixing and cable systems, and severely criticised the way in which trolley poles were erected in many cases, a neglect of the stresses and strains being shown. He advised tramway engineers to study the question of strains on poles, and learn what they could from the experience of telegraph engineers.

Mr. Sayers, in reply, felt happy that there had not been much contradiction or destructive criticism. He admitted his estimate of attendance on sub-stations (3s. weekly) was low. The greatest density of traffic affected the size of feeders, and not the distance of distribution. He considered the method he gave for calculation more general than that of Mr. Eustace Thomas, as one got the general expression for the most economical density. He did not profess to compare systems. Each section of trolley wire would, of course, be fed at many points. He thought Mr. E. K. Scott quite right as to use of motors on cars, and that Mr. Swinburne's remarks were worthy of attention; the difficulty was to find anyone who would put down money to equip such a system. The trouble lay in shorts and turn-outs. It would require a paper to reply to Mr. Quin, but the life of a cast-iron pipe was 40 years, and he did think that that provision is worth greater attention.

Yesterday the meeting was engaged in discussing a paper on motor meters by Mr. Evershed.

## THE NATIONAL TELEPHONE COMPANY'S DINNER.

The seventh annual dinner of the National Telephone Company was held at the Trocadero last Friday evening, when Mr. W. E. L. Gaine, the general manager of the company, for the seventh time occupied the chair. Among the guests were the Rt. Hon. Lord Kelvin, G.C.V.O., &c., and Prof. Silvanus P. Thompson, F.R.S., while Sir Albert Rollit, LL.D., M.P., Sir Cuthbert Quilter, Bart., M.P., Lieut.-Col. C. B. Clay, V.D., and members of the staff of the company to the number of nearly 200 were also present.

The company sat down to an excellent repast, which was beguiled with operatic selections by a string band.

The dinner over,

Mr. Gaine having proposed "The Queen" in well-chosen terms—a toast which was honoured with enthusiasm, and was followed by the National Anthem—Sir Cuthbert Quilter rose to propose the toast of "The Imperial Forces of the Crown." Remarking that, in paraphase of the old quotation, "One touch of danger makes the Empire one," the speaker referred to the debate on the Spion Kop correspondence which he had just left, and pointed out that not the least aspersion was thrown on any soldier of any rank; mistakes had been made which must one day be inquired into, but "the time is *not now!*" The part which electrical engineers had played in the war was no small one; Major Crompton was at the front with his gallant corps, and of the National Telephone Company's employés alone not less than 1,000 had gone out to South Africa, while the company had charged itself with the support of their wives and families—an announcement which was received with cheers.

The toast was coupled with the name of Lieut.-Col. C. B. Clay, V.D., who, after lamenting the absence of Sir Jas. Ferguson, pointed out the fact that the Volunteer forces, with which he had been connected for 20 years, were now on an entirely new footing; but too much must not be asked of them—it was out of the question for them to spend a month in camp every year.

The Chairman next rose to propose "The National Telephone Company," but first he read a letter from Mr. J. S. Forbes, regretting his enforced absence through a recent illness. Lord Harris, who has just been "embodied" with the Yeomanry, also apologised for his consequent absence. The Chairman stated that the company has now 968 exchanges in the United Kingdom, of which no less than 840 have already been remodelled and made equal to any in the world. In spite of the opposition to the company, the year 1899 constituted a record, 21,000 subscribers having been added to its *clientèle*, while there are now 176,000 subscribers' telephones connected up—*i.e.*, one to every 214 of the population. This, said Mr. Gaine, compares most favourably with almost any foreign country. The number of messages transmitted last year amounted to 617 millions; during the same period the Government carried 87 millions of telegrams, inclusive of foreign ones. The average cost of the former was less than ½d., while the latter worked out at 7½d. The comparison seemed to afford the speaker much satisfaction, but we fail entirely to perceive its value, for the two things are quite incommensurable. The Chairman had some strong things to say of the trunk service as worked by the Post Office; from the reports of district superintendents he found that delays of from half an hour to two hours were daily experienced in all parts of the country, while, in his opinion, no trunk service worth the name would require more than five minutes waiting. Mr. Gaine carefully explained that his remarks were not aimed at the *personnel* of the trunk service, with which he had no fault to find; he thought that the two millions sterling voted by Parliament last year for the Post Office competitive telephone service would have been better expended on improving the trunk service—a very natural view to take!

The toast was coupled with the name of Sir A. Rollit, whose lively reply was heartily appreciated. In the course of his remarks Sir Albert made a complimentary reference to each of the managerial staff and the visitors, alluding in the latter case to the highly scientific character of the company's vocation.

A graceful allusion was also made to the late Prof. Hughes, whose invention of the microphone had made telephony practically possible. Mr. Gaine's forensic gifts were cordially appreciated, and Mr. Anns's skill in dealing with statistics was said to enable the chairman to prove anything!

Proposing "The Visitors," Mr. J. C. Chambers paid a touching tribute to Prof. Hughes, and coupled the toast with the names of Lord Kelvin and Prof. Thompson. In his reply Lord Kelvin declared that telephone troubles were not confined to this or any other country—everywhere, in 99 cases out of 100, the main fault lay in the users. Lord Kelvin was astonished to hear recently that the Glasgow telephone service was the worst in the kingdom; he regarded this as a great compliment, for in his opinion the service there was exceedingly good. He thought that the opposition to the company could not all be free from personal animus and other unworthy sentiments. Referring to a remark of Sir Albert Rollit's, that the company got more kicks than ha'pence, Lord Kelvin deduced that it received 617,000,000 kicks per annum! But, in his opinion, they were mere pin pricks, and in 10 years' time the company would be even more highly respected than ever.

Prof. Thompson also replied, and pointed out the great importance of the company's undertaking, employing as it did over 10,000 persons. Referring to the danger of swamping private enterprise by over-municipalisation, he protested strongly against the growing tendency in this direction; on the other hand, its trials had kept the company alive to the necessity for constant improvement, for which there was still ample room. The company was now 21 years old, and the Professor hoped to be present at its celebration 21 years hence.

Referring to the dream of cross-Atlantic telephony, and other not impossible inventions of the future, the speaker concluded with the couplet—

"The good of former times let others state—
I think it lucky I was born so late!"

Mr. T. A. Prout proposed an extra toast, that of "The Chairman," in a speech which rang with sincerity—one might say of affection, and Mr. Gaine having suitably replied, the proceedings came to an end.

During the evening various solos were agreeably rendered by Miss Gwendoline Dew, and Messrs. Will Edwards and Seth Hughes, accompanied by Miss Edith Bristow.

## BILLS BEFORE PARLIAMENTARY COMMITTEES.

### South Lancashire Tramways Bill.

The Select Committee of the House of Commons, presided over by Mr. Seale Hayne, had before them on Tuesday, Wednesday, and Thursday last week the consideration of the South Lancashire Tramways Bill. Mr. Balfour Browne, who appeared for the promoters, Mr. J. B. Atherton, Mr. J. Wherton, Mr. W. M. Brigg, and others, explained that the proposal was to construct 45 different tramways, which would connect important centres in Manchester and Liverpool. The trams would be run by electricity, and in consideration of the expense thereby involved, they asked that the Tramway Acts should be so altered that the period at the end of which the lines might be purchased by the local authority, without taking into account the goodwill, should be extended to 35 years.

Evidence in favour of the Bill was given by Sir John Willox, M.P., Mr. J. Fairclough (the Mayor of Leith), Mr. James Atherton, Mr. J. E. Waller, and others. Mr. Atherton in his evidence said it was the intention to light the entire route of the tramways, town and country, by electricity. Mr. Walker, who is acting as engineer for the scheme, estimated that the construction of the tramways would cost £488,959. The electricity for lighting the line of route would cost less than ¾d. a unit.

After hearing evidence against the scheme, the Committee approved the preamble of the Bill.

### Baker Street and Waterloo Railway.

At the resumed sitting of the Committee on Wednesday last week, Mr. Wilkinson, the general manager of the Great Western Railway, gave evidence in support of the Bill, and said he considered such a line would be extremely useful in enabling passengers to get from Paddington to the West End and Waterloo.

Mr. Owens, the general manager of the London and South-Western Railway, also supported the Bill, and said he considered it was a blot upon London that there should be such poor communications between the different termini.

Sir W. Pollitt, the general manager of the Great Central Railway, having given evidence in favour of the Bill,

Mr. Hale, the deputy chairman of the petitioning company, said he did not anticipate that there would be any difficulty in obtaining the necessary capital for the extension—in fact, they had made a contract with the London and Globe Company.

Sir Benjamin Baker, C.E., said it was proposed to carry the public over the whole six miles of the new railway for 2d. The present fare by omnibus for the same distance was 5d., in addition to which there would be a saving of time.

Sir J. Wolfe Barry, examined in opposition to the scheme, said that the extension of the line to Paddington really meant a complete reversal of the idea under which the line was sanctioned—which was to establish a communication between the north and south of London.

The Committee then adjourned.

On Thursday the examination of Sir J. Wolfe Barry was continued. He gave particulars of the experiments which the Metropolitan and the District Railways were making for the purpose of working their lines by electricity. The electric trains, he said, had been running experimentally for some weeks, and when the Board of Trade had reported on the result of their inspection, the trains would be run for the conveyance of ordinary passengers.

Mr. J. Bell, general manager of the District Railway, contended that the proposed extension was not required in the interests of the public, and he did not believe it would be a financial success.

After hearing Mr. Littler, Q.C., against the Bill, the Committee stated that they had decided to pass the preamble.

### Charing Cross and Strand Electricity Supply Bill.

This Bill came on Thursday and Friday last week before a Committee of the House of Commons, presided over by Mr. A. H. Brown. Mr. Pember, Q.C., Mr. Shiress Will, Q.C., Mr. G. Fitzgerald, and Mr. Holland represented the promoters. The West Ham Corporation, the Whitechapel District Board, and the London County Council appeared by counsel in opposition to the Bill.

Mr. Pember explained that the object of the Bill was to empower the company to acquire a site at West Ham for the purpose of providing a generating station for the supply of the City. The site had the approval of the City Corporation, and it was situated far away from any residential district, being surrounded by factories, &c. The site of the generating station had an area of about 7½ acres.

Mr. Patchell, C.E., the engineer to the company, said that the mains would extend from West Ham for about 3¼ miles to the boundary of the City, *viâ* Poplar, Mile End, and Whitechapel, and they would also be extended to portions of the West End.

After hearing considerable evidence both for and against the Bill, the Committee decided to approve the preamble.

### Cork Electric Tramways.

A Bill to authorise the construction of an electric tramway from Cork to Blackrock came on Thursday and Friday last week before a Committee of the House of Lords, presided over by the Earl of Lauderdale.

Mr. Pember, Q.C., in stating the case for the promoters of the Bill, said that the tramway company now had a line working to Ballintemple, and they sought in the Bill before the Committee to get a further extension to Blackrock. The inhabitants of the district were enthusiastically in favour of this scheme, and the only persons who had anything to say against it were the Cork, Blackrock and Passage Railway Company. It had been urged that the company was not in a proper financial position to carry out the scheme, but he might mention that last year—the first year of its working—it had paid a dividend of 5 per cent. The line would be mostly single, but double in some places.

Mr. Charles Merz (secretary and manager of the Cork Electric Tram and Lighting Company) stated that one of the promoters of the Bill was Mr. William Murphy, an inhabitant of Cork, who was connected with large electric undertakings. The capital of the company was £200,000, half of which was preference and half ordinary, while the debentures represent £70,000. There were about 8 miles of rail, some double and some single, and the tramway had so far been very successful indeed. Last year they carried five million passengers at an average charge of 1d. per person, and as the result of the first year's work in lighting and traction they had a net profit of £12,000, which enabled them to pay a dividend of 5 per cent. and to carry forward £1,000. The system was the overhead trolley system, to which there was no objection in the district. The estimate for the construction of the proposed tramway was about £6,000.

After hearing further evidence, the Chairman of the Committee intimated that the Committee saw no reason why the Bill should not proceed, but they thought that the promoters ought to give a protective clause to the railway company in respect of one of their bridges which they intended to cross over.

Mr. Bushe, who represented the railway company, did not press for the insertion of such a clause, and accordingly the Bill was ordered to be reported to the House.

### London United Tramways Company, Limited.

Sir U. Kay-Shuttleworth presided on Friday of last week over a Select Committee of the House of Commons to consider the Bill of the London United Tramways Company, Limited, which was opposed by the Middlesex County Council and certain frontagers who considered they would be affected by the trams passing along their places.

Mr. Balfour Browne, Q.C., who appeared for the promoters of the Bill, said that they asked for power to construct about 18 miles of tramway in the county of Middlesex. The company already had a very extensive system of lines in West London, running from Hammersmith Broadway to Kew Bridge, from which point they had powers to carry a tramway to Hounslow. They also possessed a line which ran to Acton and Ealing. At present all the lines had been worked by horse traction, but the proposal was to introduce the electrical overhead trolley system. A generating station was in course of erection for the supply of the necessary power, and it was hoped that it would be ready in July. The proposals of the Bill were to extend the existing line from Acton *viâ* Ealing to Hanwell, and from Heston and Isleworth *viâ* Twickenham and Teddington to Hampton Wick. He believed that the opposition of the Middlesex County Council was based upon a suggestion that at some future time that body, with the London County Council, would carry out a scheme of tramways themselves. But his clients were in possession of the district, and the Middlesex Council was not the purchasing authority under the Act.

Evidence in support of the Bill was given by Mr. Clifton Robinson, the general manager of the company, who explained that the electric cars proposed to be put upon the road would each accommodate 80 passengers, as against 36 or 44 in horse cars. He considered that the adoption of electricity would lead to a large increase in the amount of passengers carried. At present they carried about 10 million passengers a year, and they anticipated that that number would increase to between 40 and 50 millions when electricity was in use, and the system extended.

After hearing other evidence the Committee adjourned.

On the Committee resuming on Monday, evidence was given on behalf of the frontagers in opposition to the Bill, and Mr. Duncan, at one time a member of the Urban District Council of Twickenham, said that the scheme of the present Bill was not viewed favourably by the residents in the neighbourhood, and especially were they opposed to a tramway passing along the Richmond Bridge Road.

Sir J. Whittaker Ellis and Mr. C. R. Brereton, C.E., having given evidence in opposition to the scheme,

The Chairman said that with regard to that particular line, the Committee were prepared to assent to it on certain conditions, having regard to the importance of the road to ordinary traffic to and from London and other places. First, all curves must be improved; secondly, as far as possible 9 feet 6 inches must intervene between the footpaths and the lines; thirdly, where two footpaths did not exist the Committee must be satisfied as to the provision of a second in case of building taking place; fourthly, the Committee must be satisfied that a double line was not required where a single line was proposed; and lastly, that the interlacing opposite St. Stephen's Church should be further considered. While assenting to the preamble generally, the Committee would examine the deposited plans in regard to width of roads, single lines, curves, and so forth.

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This Bill again came before a Committee of the House of Commons on Tuesday, when the deposited plans of the proposed railway were examined. After some discussion, the Committee announced that they would sanction the interlacing of the lines opposite St. Stephen's Church, East Twickenham. The preamble of the Bill was then passed, and the Bill ordered to be reported to the House.

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### The County of Durham Electric Power Supply Company.

The Special Committee of the House of Commons, appointed to inquire into the various electric power Bills submitted to Parliament this session, commenced its proceedings on Thursday of last week. Sir J. Kitson is chairman of the Committee; the other members are Sir Andrew Scoble, Mr. G. T. Bartley, Mr. Ashton, Mr. Howard, Mr. Billson, and Col. Long. Mr. Bonham Carter is acting as referee. The first Bill to be considered is that promoted by the County of Durham Electric Power Supply Company. Mr. Balfour Browne, Q.C., Mr. Worsley Taylor, Q.C., and Mr. Moon represented the promoters. Those petitioning against the Bill were the Felling District Council and the Hebburn District Council (represented by Mr. Fitzgerald, Q.C., and Mr. J. P. Williams), the Lambton Colliery Company (represented by Mr. E. H. Lloyd), and the promoters of the Tyneside Electric Power Bill of the present session, for whom Mr. Pember, Q.C., Mr. Baggallay, Q.C., Mr. H. Lloyd, and Mr. Frere appeared.

Mr. Balfour Browne in opening the case for the Bill, said the promoters sought to obtain power for incorporating and conferring certain powers on the County of Durham Electric Power Supply Company, for the supply of electricity in bulk, and for other purposes. It was proposed to establish a central generating station at Gateshead from which energy in bulk would be supplied to local authorities over a wide district. Those who were promoting the Bill were connected with the Gateshead tramways, and also with the electric lighting of Gateshead and Jarrow. They were also interested in the electric lighting order which the Durham Corporation had agreed to transfer to them. The districts for which the company sought power to supply electricity in bulk, included Gateshead, Jarrow, Durham City, and Seaham Harbour. It was intended to erect a central generating station at Gateshead for the supply of current, and it was expected that the company would be thus able to supply at very cheap rates. Under the Bill they would not be able to compete against any local authority in the matter of supplying electrical energy—the idea being that they would be very useful to local authorities who wished to light their towns by electricity, or run tramways. By producing the energy on a very large scale they would be able to manufacture exceedingly cheaply, so that it would be to the advantage of local authorities to purchase from them rather than generate their own electricity. At the present time there was a good deal of discussion as to how far municipalities should compete against private enterprises in the matter of trading, and he asked the Committee to decide that the supply of electricity to the district in question could be more properly placed in the hands of a private company than in the hands of the local authorities. Generally speaking, in Durham the local authorities took that view themselves, and while they wished to retain the power of distributors, they had no desire to go in for manufacturing. The company would be obliged to supply electricity to any authority within the district that desired, but they were not asking for any compulsory powers to compel anyone to purchase a single unit of electricity from them. As to the cost of manufacture, that was estimated at a trifle over ½d. per unit, and it was hoped by the company that they would be able to supply users at 1d., or at the most 1½d., per unit.

Mr. Ferranti gave evidence in favour of the Bill, and said that by cheapening production the company would be able to supply small manufacturers and others with electrical power at a very cheap rate. Examined as to the cost of the scheme, the witness said that the total outlay was estimated at £500,000, made up as follows:—Generating plant, £297,000; cost of transmission, £160,000, the balance being made of contingencies. He had gone very carefully into the cost of manufacture, and it worked out at about 0·44 of 1d. per unit. To that would have to be added 0·21d. per unit, the cost of transmission of energy. The high pressure system was that which it was proposed to utilise, as that was the best system for transmitting power over long distances.

On the re-assembling of the Committee on Friday, the Chairman at the outset of the proceedings said he thought it would be convenient that he should state that the Committee having before them the report on electrical energy, generating stations, and supply, they adopted certain of the conclusions of that report. They accepted the recommendations contained in the report of the Joint Committee of 1898 on Electrical Energy in the following respects, viz., compulsory powers for acquiring sites for generating stations, and lands or easements for pipes and mains therefrom and other works, whether within or without the area of supply, might as a principle be granted, but they were prepared to hear petitioners who objected to the particular sites selected by the promoters. In the case of powers being given for the erection of generating stations outside the area of supply, powers might be given for laying mains in streets leading from the generating station to the boundary or area of supply, the local authorities having the option of breaking up and re-instating the streets at the undertakers' expense, but the Committee were prepared to hear petitioners who alleged that they were under special disadvantages arising from the Bill now under consideration. He would make no reference to the other paragraph of the report, but the Committee reserved to itself the right of considering them.

Sir F. Bramwell, examined by Mr. Moon, said that during the whole of his life he had devoted great attention to the question of power distribution. He was of opinion that if cheap electricity was obtainable it would be devoted to a good many purposes for which it was not now utilised. He had considered the figures which Mr. Ferranti had given as to the cost of production, distribution, &c., and speaking generally he supported them.

In this country, at the present time, supplying electricity in bulk is in the nature of an experiment, is it not?—I hardly think an experiment.

In this country?—No. It is in the early stage, but I think it is well established that it can be done, and it is beyond the domain of experiment, but with regard to getting people to use it, I do not think they are yet trained to it.

Replying to Mr. Bartley, the Witness said that this country was very much behind other countries in respect to the use of electricity for power purposes for manufactories, and unless we had something of the sort proposed by the Bill under consideration, we were seriously hampered in our contest with other nations. What was wanted was the means of distributing power commodiously and cheaply, and that could only be done on a very wholesale scale.

Councillor J. Todd (chairman of the Electric Lighting Committee of the Durham Corporation) gave evidence in favour of the Bill. He said the Corporation were particularly interested in obtaining a supply of electricity on the most favourable terms for lighting, traction, and power purposes. He was quite certain that electricity could be produced upon a great scale at a very much cheaper rate than upon a small one. He felt convinced that the traction of the future would be electricity.

Mr. William Grey, deputy-Mayor of Durham, Mr. Alderman Scott (Gateshead), Mr. Alderman Hindmarsh (Gateshead), Alderman Armstrong (Jarrow), Mr. Stephen Sellon, M.I.C.E., followed with evidence in favour of the Bill.

Mr. W. L. Madgen, one of the promoters of the Bill, was also examined. He said that the Bill would tend to cheapen electricity to the consumer all round. A man living in a small district would get his current at practically almost the same price as the man in the larger district. In other words, the manufacturer would not have to consider where to place his works. Tramways and light railways would all tend in the same direction.

The Committee then adjourned.

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On Monday Mr. Madgen was cross-examined. He said that, although it was true that one company was to generate electricity and another company, allied to it, to distribute it, the interests of the consumer would come in by reason of his getting his electricity cheaper than if these different districts put down separate generating plants. If the Bill was passed it would make the supply of electricity possible in many of the pit villages of Durham, where to-day they were using oil.

Other witnesses having been called in support of the Bill, the case for the promotors was closed, and the rest of the sitting was devoted to the hearing of local evidence from Felling and Hebburn in opposition to the Bill.

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At the sitting on Tuesday Mr. Baggallay, Q.C., addressed the Committee on behalf of the Tyneside Electric Power Bill, and opened the case for that Bill at the same time. He said that the two schemes differed in very essential particulars—both in regard to their areas and their objects. The main object in the minds of the promoters of the Durham Bill seemed to be to get power to supply their own authorised undertaking or to supply undertakings which they had arranged to take over. Their desire was to supply electrical power to a large number of tramways and light railways, and for lighting purposes—the supply of works, industries, &c., being quite a secondary consideration in the minds of the promoters. The proposal of the Tyneside Company was to supply private consumers, in other than their own districts, where they could reach them without breaking up the streets. They did not intend to compete with anybody for the supply of local authorities, whether for lighting or traction without the consent of the local authority. But what they did ask for was power to compete with anybody where they could do it without breaking up the streets. He knew that was a new claim, but the opinion of the promoters was that it was a question which had to be met, and that unless it were met somewhat in the way in which they suggested it should be, the competition in trade between the great British industrial works and the foreign ones could not be maintained on a fair basis. He did not want to say one word against the promoters of the County of Durham Bill, but it would be admitted that their business was that of promoting tramways and electric lighting undertakings, and of getting powers to supply the electricity. The position of the promoters of the Tyneside Bill was totally different. They were the largest manufacturers and producers in Tyneside, and they wanted to supply themselves and neighbours on the cheapest and most efficient terms. It was a scheme promoted in the interests of the district, and not as a commercial

speculation. They had a very strong body of evidence in support of the position which they took up, and the Bill was supported by practically all the large manufacturers on the Tyneside.

Sir A. NOBLE, vice-chairman of Sir W. Armstrong & Co., Newcastle, said that the promoters of the Tyneside Bill were all local people of strong financial position, and they were very largely interested in the most important manufactories of the district. He believed that they would be able to carry out the scheme successfully, especially as some of the promoters were already interested in electrical engineering. It would be of great advantage to engineering firms if they could obtain an economical supply of electrical power. At present they used electrical power generated by themselves, but doubtless if they could get a satisfactory supply from outside at a suitable price, they would very largely increase the use of electricity. He would be very sorry to see the supply of electricity undertaken by the local authorities in the district, because he did not think they would be able to supply as cheaply as a company. He thought it was very desirable that every facility should be given for the production and distribution of electricity in Tyneside and district, because he believed that this country had suffered in the past from the want of electrical energy for manufacturing purposes.

Mr. A. A. C. SWINTON, one of the promoters of the Tyneside Bill, and a member of the Council of the Institution of Electrical Engineers, said he had practised since 1884 as an electrical engineer, and given much attention to the distribution of electrical energy for lighting, power, and traction purposes. He thought it was very important for the manufacturers in Tyneside that they should have a good and economical supply of electrical power, such as they proposed to give under the Bill. The prices would be arranged upon what was known as the Brighton system, but not exactly the same as existed at Brighton. They proposed a sliding scale, and the prices would come down as soon as the ordinary shareholders received 10 per cent. on the capital.

Cross-examined, WITNESS said they proposed to begin by putting down one generating station at Wallsend, and possibly in course of time, as the demand increased, they would have to supplement that by two other stations.

The Committee then adjourned.

## LEGAL.

THE JANDUS ARC LAMP AND ELECTRIC COMPANY, LIMITED, *v.* JOHNSON.

THE trial of this action was begun by Mr. Justice Farwell, sitting in the Chancery Division of the High Courts of Justice, London, on Friday last week. The claim was for an account of royalties due (and the recovery of the amount thereof) under a license to use two patents; and the defendants, who counterclaimed for damages, pleaded, *inter alia*, that the articles they had made would not, even had there been no license, have been infringement of the patents. Mr. Moulton, Q.C., Mr. T. Terrell, Q.C., Mr. J. G. Graham, and Mr. A. J. Walter (instructed by Messrs. Faithfull & Owen, agents for Messrs. Payne, Galloway & Payne, Manchester) appeared for the plaintiffs, and Mr. Bousfield, Q.C., and Mr. J. Hunter Gray (instructed by Mr. George Whale) were for the defendants.

Mr. TERRELL, in opening the case, said that the license to the defendants was dated March 24th, 1898, and it was a license to use two letters patent, Nos. 15,479 of 1893, and 437A of 1895. The substantial defence made was that the goods produced by the defendants were not made under the license, and would not, if there had not been a license, be infringements of the patents, and that no royalties were due in respect of them. The defendants also set up an extensive counterclaim for misrepresentation, and for rescission of the license.

Mr. BOUSFIELD at this stage interrupted with a preliminary point of objection. He said that the claim was in respect of a license to make and sell "enclosed arc lamps for which the plaintiffs possessed certain letters patent, to wit, No. 15,479 of 1893, and No. 437A of 1895." What the defendants said was that at the time of the license the plaintiffs did not possess those patents, and those patents were not mentioned in the license. The plaintiffs said that if they made that representation or warranty, the patents were, in fact, controlling patents, and that the plaintiffs became possessed of them shortly after the date of the license. The defendants pleaded that the plaintiffs did not own those two particular patents at the date of the license.

Mr. TERRELL, continuing, said that the patents were for enclosed arc lights, and turning to the legal considerations in the case, Mr. Terrell said that when this license was granted the plaintiffs were possessed by assignment of the patent No. 437A of 1895. Then they had an agreement to buy the patent No. 15,479 of 1893. The license with the defendants was between the Jandus Arc Lamp and Electric Company, Limited, and Walter Claude Johnson, the licensee, and it stated that in consideration of the royalty of 5*s.* for every lamp made by the licensee, the licensors granted to the licensee full authority to make, use, and vend enclosed arc lamps for which the Jandus Arc Lamp and Electric Company, Limited, possessed controlling patents, in so far as related to the enclosing of the arc in two or more globes or the equivalent. The license went on to say that the licensees should have that right during the term of the patents, and that was a point which his Lordship would have to consider because of the defence which had been raised. The licensees were to affix on a conspicuous part of every lamp which they manufactured a royalty plate which would be furnished by the licensors, bearing a reference number and the inscription, "Under license to Jandus patents." Clause 5 said, "In the event of the licensors failing for a period of 12 months after their attention has been called to the matter to take proceedings against parties who make, use, or sell arc lamps which are infringements of the patents owned by them, the licensees shall be relieved of further obligation to pay royalty under this agreement." Another clause was important. It was this: "The licensors hereby undertake that they will not grant in the future any licenses to use the patents covered by this license at a less royalty than that hereinbefore agreed to be paid by the licensees without making a corresponding reduction in the royalty to the licensees." He drew his Lordship's particular attention to that, because the defendants said that the plaintiffs or one of their officials had made a misrepresentation, and that they (the defendants) had, acting on the faith of that misrepresentation, taken the license. The suggested misrepresentation was that the plaintiffs had not granted to anybody a license upon better terms than those which had been given to the defendants; and the better terms that the defendants complained of were that the plaintiffs had granted a license to somebody, not at a less royalty, but for a shorter period of time, and that the persons to whom this latter license had been granted, if the license were determined at a shorter period of time than the whole length of the patent, might thereafter dispute the validity of the patents. The clause in question was, "The licensors hereby undertake that they will not grant in the future"—and this threw light on what was the probable representation if any was made at all—"to any person or persons any licenses to use the patents covered by this license at a less royalty than that hereinbefore agreed to be paid by the licensees without making a corresponding reduction in royalty to the licensees." The license was to apply "to all forms of double enclosure." This was what was granted, and this was what the defendants might do, although the patents were not named in it. It was "that the license should apply to all forms of double enclosure except that made with the particular arrangement adopted by the Jandus Arc Lamp and Electric Company, Limited, namely, a fixed outer globe closed at the top and the inner globe removable through valve at the bottom"—that was at the bottom of the fixed outer globe. What the defendants were therefore licensed to do was to make every form of lamp with double enclosures with that single exception. The license further stipulated that nothing contained in it should confer upon the licensees the right to use the carbon feeding mechanism as described in the licensors' patents, and further that the licensees should not during the continuance of the license, nor at any time after the determination thereof, dispute the validity of the said letters patent on any ground. That was the license. There was no question as to the plaintiffs' title regarding No. 437A of 1895. Then there was this agreement of March 23rd, 1897. It was between the Electric Arc Light Company, hereafter called the vendor company, and the Jandus Arc Lamp and Electric Company, hereafter called the purchaser company. It set forth that "whereas by an indenture of assignment dated March 18th, 1897, between William Phillips Thompson of the first part, the purchaser company of the second part, and the vendor company of the third part, the said W. P. Thompson had assigned at the request of the vendor company Thompson's patent No. 207 of 1896 to the purchaser company, and whereas the vendor company claim to have certain rights in the patent known as the Howard patent No. 15,479 of 1893, which rights the vendor company believe to be the absolute right to ask for an assignment of the said Howard patent"—it turned out afterwards that they did have that right—"it is hereby agreed (1) the purchaser company will on the signing hereof pay to the vendor company the sum of £2,500; (2) the purchaser company will pay to the vendor company a further sum of £1,500 upon the vendor company assigning or obtaining an assignment to the purchaser company of the said Howard patent, No. 15,479, of 1893." The vendor company had the right, and as soon as that was ascertained they executed the assignment to the plaintiffs, who paid the £1,500. That document was dated March 23rd, 1897, and was, therefore, a good deal in advance of the license, which was dated March 24th, 1898.

Mr. Justice FARWELL: What is the date of your assignment?

Mr. TERRELL: April 27th, 1898. There was an antecedent assignment to the Electric Arc Company.

Mr. BOUSFIELD said that the point was, had the defendants on March 24th, 1898, a license under the patent of 1893?

Mr. Justice FARWELL: What you are granted is a licence for all the lamps for which the Jandus Company possessed the controlling patents. Did they possess controlling patents? They did in equity, because they had the contract.

Mr. TERRELL, resuming, said that under the license the licensee was not bound to do anything. If he did anything, then the plaintiffs had to establish that he had done it, and if they did so, then they were entitled to an account of royalties. The patent of 1893 was the more important, but if they got the defendants within one, that would be enough for the purpose. The specification of No. 15,479 of 1893 was entitled "Improvements in electric arc lamps," and the sixth claim was for "an arc lamp having its arc enclosed in a transparent or translucent envelope closed air-tight at all points below the arc, and provided with a plug at the top having a closely fitting feed opening for the positive carbon." That was one of the things the defendants was licensed to do, and he (Mr. Terrell) would show that he had done it literally. Then there was a very curious defence to the effect that he did not want to dispute the validity of the patents because, being a licensee, he could not do so; but he would produce specifications against the plaintiffs, and he devised this scheme of quoting specifications, and said he would do so by way of construction, so as to limit and reduce the scope of the patents. But there was authority to show that that could not be done. In Clark *v.* Adie it had been settled and decided that they could not do that.

Mr. Justice Farwell: It seems to me to be an indirect way of allowing a licensee to attempt to impeach the patent.

Mr. Terrell concurred. He submitted that the defendants had acted under this patent, and was stopped from saying anything about its validity. Then with reference to the 12th claim in the specification, the plaintiffs said that the defendants had also taken that. It was "an arc lamp, having its arc enclosed within a transparent or translucent envelope, an auxiliary transparent or translucent envelope closed on all sides surrounding said arc-enclosing envelope, and feed openings in the envelopes, whereby the two sides of the arc-closing envelope are maintained at a comparatively uniform temperature, and fracture is avoided." With reference to the first claim, his Lordship would see that it was limited to the claiming of a combination of a transparent envelope provided with certain things. The 12th claim dealt with two enclosing envelopes one within the other. The defendants had taken both. Then with regard to patent No. 437A, the claim which the plaintiffs said that the defendants had taken was claim 1: "In an arc lamp, prolonging the life of the carbon by enclosing the arc within two or more chambers so arranged that the upper part of the outer chamber is made airtight, or nearly so, while the lower part permits some communication with the outer atmosphere, and the inner chamber permits a limited communication between its interior and the gaseous contents of the outer chamber or chambers, the combination of the chambers being so devised as to surround the arc with inert or non-oxidising gases, and prevent or minimise the access of the oxygen of the air to the carbons as herein set forth."

Mr. Justice Farwell: Does that differ from the other one? Is it not the same thing very much?

Mr. Terrell said it was practically the same thing, but with improvements. But he wanted, if he could, to avoid going into any science in this case. What the plaintiffs had done was, that they had bought one of the lamps which defendants had made, and he would now call Mr. Clerk to tell the Court what it was.

Mr. Justice Farwell: What does "Jandus" mean? I have heard of Janus.

Mr. Moulton: "Jandus" is the unfortunate name of a fortunate man.

Evidence was then called, and Mr. Dugald Clerk was examined and cross-examined, but we do not consider it necessary to publish his evidence, which was mainly confined to details of construction, and his Lordship had said the validity of the patent could not be contested.

Mr. Bousfield: As a licensee, your Lordship sees that this present objection to validity comes at a point of date prior to the time I was licensee. I say you have cheated me into a position, in which you have made me licensee, by telling me you had got controlling patents, whereas the fact is that you have got patents which are for the merest trifles and details, and do not prevent the world at large or give any monopoly at all with regard to this manufacture. That is my position. They have induced us to put ourselves in the position of licensees by telling us they had patents. They were never named to us, and we did not know what they were. We had to take it on trust from them, which would enable a monopoly of these double enclosed globes to be maintained. It turns out that the idea was quite an old one, that they can only maintain these patents for very trifling details, and that they are not controlling patents because, on the existing state of knowledge then whether this patent be good or bad, there were a number of forms of double enclosed gas lamps which were known and open to anybody to make. That is my position. All I want to succeed upon is to show that these patents are so narrow that no monopoly could be given by them at all. They are only good for something which is very narrow indeed.

Mr. Terrell said there was a claim and counterclaim. On the claim the plaintiffs had to establish that the defendants had done something that was within the patents. On the counterclaim they claimed rescission of the whole agreement, and to claim rescission of the whole agreement would go to the root of the action on the claim as well as the counterclaim, because if the Court rescinds the agreement, there is no royalty due at all.

After some further discussion, his Lordship said it occurred to him that they ought to take the counterclaim first.

Mr. Terrell felt that that would be the best plan. He wanted Mr. Clerk to go out of the box and for his learned friend to open his claim and establish that the plaintiffs made the representation, and that he acted on the faith of that representation. When he had done that he would be entitled to call witnesses to prove the representation was untrue and these were not controlling patents, and then he would be entitled to cross-examine Mr. Clerk.

His Lordship: You offer to recall Mr. Clerk?

Mr. Terrell: Yes, I will recall Mr. Clerk for that purpose, to be cross-examined.

His Lordship: What do you say to that Mr. Gray? (Mr. Bousfield having left the Court).

Mr. Gray: I cannot object. The only purpose we had in cross-examining is that while we have the witness in the box we want to get all we can from him.

Mr. Gray then proceeded to open the defendants' counterclaim. His Lordship, he said, would notice in the recital that the plaintiffs guaranteed that they possessed controlling patents. If he could satisfy his Lordship that the defendants acted upon that representation in executing the license, of course he was entitled to rescission. But there was another ground in the amended pleadings which he submitted was a separate ground for rescission even if he failed on that particular ground. He thought it would be desirable at the present stage to call his Lordship's attention to the letter to show exactly what the plaintiffs undertook. Paragraph 5A of the amended defence said that "while the negotiations for the said license were proceeding, one Bernard Drake, acting as agent for the plaintiffs, wrote to the defendant a letter dated March 15th, 1898." This letter ran: "I send you herewith the clauses accepted by the other licensees to which you refer, and trust you will now get the license signed with these alterations. I give you my assurance that these terms are the best we have allowed to anyone, with the exception, of course, of the Stewart Company, who, as you know, were the first people." The rest of the letter was not important. That letter of March 15th, 1898, was in answer to a letter dated March 10th, 1898, from the defendant to Mr. Drake. In that letter the defendant wrote, "Give me your assurance that the license that you ask me to sign is precisely the same as that signed by the other licensees," and the answer to that was, "I give you my assurance that these terms are the best we have allowed to anyone." Counsel asked his Lordship to say that the intention of that paragraph in the letter of March 15th, 1898, was to convey to Mr. Johnson the impression that the terms were, if not identical, the best that had been given to any licensee.

His Lordship: Certainly the best, but I do not think it was intended to say they were the same.

Mr. Gray, continuing, said that his Lordship would see that if his construction was right—if the undertaking given by Mr. Drake was one that went beyond Clause 6 of the license as regards the amount of the royalty—then any clause which enabled any other licensee at any time or under any circumstances to dispute the validity of the patent or patents, was a clause better than the one the defendant had got.

His Lordship: I understand your objection to be this: A licensee cannot dispute the validity of the patent; it is beneficial for a licensee to be able to dispute the validity of a patent, and therefore, the shorter the license the more beneficial it is; but the result of it would be—no license most beneficial. That cannot be the meaning of it.

Mr. Gray said that after the expiring of the license, the licensee was of course, entitled to dispute the validity of the patent unless he had undertaken not to dispute the validity, not only during the term of the license, but afterwards.

His Lordship: Do you say that some other licensee had got a license without the terms "nor at any time after the determination thereof."

Mr. Gray: I say that he had not only that, but that he had power to determine the license within three years after the license had been granted, and he could dispute the validity of the patent if he chose.

His Lordship: Very well, then there are two points on misrepresentation, the one is as to "on best terms," and the other as to their being controlling patents?

Mr. Gray: Yes.

His Lordship: Of course, you have to call Mr. Johnson to show that he believed they were controlling patents, and that he relied upon it?

Mr. Gray: If your Lordship pleases, then I had better call him at once.

Mr. Walter Claude Johnson, examined by Mr. Gray, said he was the defendant and traded as Johnson & Phillips. He was probably the largest manufacturer of arc lamps in the country. He entered into negotiation with Mr. Drake, the agent of the plaintiff company in connection with the license. The negotiations were carried on partly in writing and partly verbally. He obtained a draft of the license sometime before February 9th, 1898. It contained the words that the Jandus Company owned controlling patents. The form was printed. Before signing the license he had not seen the licenses given to any other licensees. He expected that the patents were controlling patents. If he had known that the patents were not controlling patents, he would not have executed the license.

Cross-examined by Mr. Moulton: Your connection with the Jandus patents, both English and foreign, was a very intimate one, was it not?—Well, I think you possibly know to what extent I was interested.

His Lordship said that he did not.

The Witness replied that he was a shareholder in the English Jandus Company. He was engaged in forming a company to work the patents in France, and was one of the vendors. He received a quantity of shares fully paid up. He did not personally see the prospectus with regard to that company. He should think there must have been a prospectus issued. There must have been. He might have a copy of it at home. The French company was formed in February, 1897. He might have manufactured 500 lamps for the English company. The company had more orders than they could compete with, and asked witness to assist them. He knew Mr. Drake well, and had gone into the matter with him at the time of forming the company. He was aware that the company were getting the Howard patent at that time. It might be that he knew they were getting it early in 1898. He thought that Drake told him at the time they were in negotiation with a man named Marks about the Howard patent. He knew it was a question of getting it from Marks. He knew that the plaintiff company had the Barton and Jandus patents and knew that they were getting the Howard. There was no other which they possessed so far as he knew. He knew it was to be a combination of the Howard, Barton, and Jandus patents. He was chiefly concerned in the actual turn-out and sale of the lamps. He would not go so far as to say that the plaintiffs practically monopolised the market at that time. They had certainly the lion's share of the trade. He doubted very much whether they had a monopoly of the trade now. He thought they were losing it very rapidly.

Will you tell me a single big maker who is not a licensee of theirs?—I shall have to refer you to my commercial assistant. I cannot go into matters of that kind. I manufacture other things besides lamps.

Further cross-examined: He could not mention the name of a single large maker of enclosed arc lamps who was not a licensee of the plaintiffs. The question whether or not a patent was a controlling patent or not was a matter of opinion. His cause of com-

plaint was that his license was not what Mr. Drake represented it to be.

We will see about that. First of all your license was for the whole period?—Yes.

You have got all we can give you, have you not?—Yes, too much.

Killed with kindness, in fact?—Yes; of course, I want to escape from it, undoubtedly.

Cross-examination continued: He did grumble about having the license given for the whole term. He wanted to be on the same terms as everybody else.

You wanted it for the whole term?—My letters show I did it to please Mr. Drake.

You say this was not a commercial but a charitable act?—No, I say that Mr. Drake repeatedly asked me, and at last I fell.

The WITNESS stated that the license to the General Electric Company was better than his because they could escape being bound by it, and he could not. He, of course, knew what was in the document before he signed it.

At this stage the hearing was adjourned.

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Further cross-examined, the WITNESS stated that he had spoken to Mr. Drake about the royalty. He (witness) was concerned that no one should have a lower royalty than himself. What he did was to oblige Mr. Drake. At least that was one of his reasons. There was a clause that the royalty should cease in the event of the patents being declared invalid by a Court of Competent Jurisdiction.

Re-examined by Mr. BOUSFIELD: If the patents had been controlling patents, it would, in his opinion, have been a profitable thing. In his view, the license was a burden to him. He thought the majority of the licensees considered it to be a burden. The General Electric license was a license for the full term, but there was the option to terminate it after three years on six months' notice. In his view that was a material difference. If he had known that some other licensee had a license for the full term with an option to terminate at the end of three years, he would not have signed the license which he did sign. He understood that the assurance he required as to his license being the same as other people's was given to him. In his view it was an important advantage to have the option of terminating the license at the end of three years. If he had that advantage now he would be very well content with his license.

The evidence of the Witness having concluded, his LORDSHIP said he could not see that the misrepresentation was made out.

Mr. BOUSFIELD said he should like to call a Mr. Wunderlick on this part of the case.

Mr. WUNDERLICK, called and examined, said he was formerly in the employ of the Jandus Company, but subsequently was employed by Messrs. Johnson & Phillips. He had had a great deal to do with enclosed arc lamps, and became very expert with regard to that subject. He had himself made some inventions with reference to double enclosed lamps, and had made investigation in the field of patents and so on, and he gave the defendants the results of his investigations. He had studied the Howard patent with others, and came to a conclusion adverse to the validity of the patent. He informed Mr. Howard of that in July or August, 1898.

This closing the evidence on the defendants' counterclaim, Mr. BOUSFIELD submitted that the misrepresentation was embodied in the contract itself.

His LORDSHIP: Omitting the word "controlling," do you say that there is a representation that the patent was a valid patent then? It is a grant of the use of existing patents. There is no misrepresentation then. They are merely descriptive words.

Mr. BOUSFIELD remarked that a controlling patent need not necessarily be a valid patent. The learned counsel submitted that Mr. Johnson had given his evidence with the greatest fairness. At the time the license was granted the matter was an unimportant one to him. His firm did not go into the matter of these lamps for 12 months after the license was granted. Messrs. Johnson & Phillips made other things besides lamps, and one could quite understand that this would be a very trifling thing to him at the time when the license was granted. Although Mr. Johnson could not remember the exact conversation which he had with Mr. Drake, the impression he got from the conversation was very clear.

Mr. Justice FARWELL said that the onus lay on Mr. Bousfield to prove misrepresentation, and he had not done so.

Mr. BOUSFIELD said that although Mr. Johnson could not speak with certainty as to the details, yet he was certain that the basis of the whole negotiation was that he was to get "controlling patents," and there came in the importance of the draft agreement. That confirmed the defendants' view, because the words therein defined the patents as being controlling patents. It was a description of what the defendants were purchasing. This was a sale of rights by description, just the same as the sale of goods by description, and the description was the result of the prior negotiations. The whole basis of the thing was that the defendants were to get rights under controlling patents. He was not able to give the details of interviews upon the subject, but the defendants were able to give the general result. If this license could have given the defendants valid protection, he would not be there fighting now to get rid of it.

Mr. GRAY, following Mr. Bousfield, submitted that the words "controlling patents" meant something more than a mere adjective applied to the word "patents." The plaintiffs could have said that they possessed "patents," but with the qualifying word they implied that their patents could control the market and prevent any other double enclosure lamp at all. Then the terms were to be the best given to any other licensee.

His LORDSHIP, after pointing out that the defendants themselves had disclaimed any imputation of fraudulent intention in the representations made to them by the plaintiffs' agent, said that the counterclaim sought to set aside this license on the ground of misrepresentation. It was said that at the time of the license being entered into the plaintiff company did not possess controlling patents. What controlling patents were, was, perhaps, not altogether plain; but however that might be, that was the only representation alleged, or that it had been open to the defendants to allege, and it was reasonally plain on the evidence of the defendants that they did not remember any other representation having been made to them. He (Mr. Justice Farwell) held as matter of construction that there had been no misrepresentation at all. The fact was that the defendants knew a great deal about these matters, and it appeared plain to him that what he was dealing with were patents merely described as controlling patents, meaning the Howard patents and nothing else. He understood that no one else could make enclosed lamps in this country, which showed that he held these patents to be valid patents. As to the letter asking an assurance for a license which should be on precisely the same terms as those given to other licensees, it was only fair both to Mr. Drake and to Mr. Johnson to say that there seemed to have been no intention on either part to deceive. Mr. Drake gave the assurance that the terms he was offering were the best that his company gave to anybody except Stewart, who, as he informed the defendants, were the first people. The Electric Lighting Company could at the end of three years put an end to their license, and they were freed from the condition put upon other licensees that they should not contest the validity of the patent on the termination of the license. The defendants now complained that while they had to run the whole term of the license they had not a similar provision; but it was quite plain that at the time when they took that license they were anxious to get it for as long as they could because they thought it was a good thing. They knew as much about the matter as Mr. Drake did, and the suggestion that if they had known about that proviso in the license to the Electric Lighting Company they would not have accepted the license, his Lordship could not adopt. His Lordship was, therefore, of opinion that the license was given on the best terms, and, therefore, he must dismiss the counterclaim with costs.

His Lordship then heard further evidence on the plaintiffs' claim in the action.

Mr. DUGALD CLERK recalled, and further cross-examined by Mr. BOUSFIELD with reference to Howard's patent. He said that precautions were taken in that specification for enclosing it airtight by means of a washer, which was nipped in with screws and other equivalents.

Now, I put it to you that, having regard to the knowledge at this time, "closed airtight at all points below the arc" means closed airtight in the manner described in this specification?—Well, I do not think so. I think it means closed airtight in any way.

Mr. JAS. SWINBURNE, examined by Mr. MOULTON, said he had read the Howard patent. With reference to the 6th claim, the arc lamp had its arc enclosed in a transparent or translucent envelope. It was closed airtight at all points below the arc, and was provided with a plug at the top, having a closely fitting feed opening for the positive carbon. In his opinion it fulfilled the description of Claim 6. In Claim 12 the arc lamp had obviously "an auxiliary transparent or translucent envelope enclosed on all sides, surrounding said arc-enclosing envelope." It had feed openings in the globes, and the whole arrangement gave that.

Gives that effect?—Yes; but that is not the result of the feed openings.

You meant "whereby the two sides of the arc-enclosing envelope are maintained at a comparatively uniform temperature and fracture is avoided" describes the effect of the whole combination?—Yes; an auxiliary transparent or translucent envelope closed on all sides surrounding said arc-enclosing envelope, and feed openings in the envelopes, whereby the two sides of the arc-enclosing envelope are maintained at a comparatively uniform temperature and fracture is avoided.

Therefore we made in accordance with the claim?—Yes.

His LORDSHIP: You do not ask about the other specification?

Mr. MOULTON: No, I do not rely on that.

Cross-examined by Mr. BOUSFIELD: I put it to you that what this specification means by "closed airtight" is such airtightness as you would get by the insertion of a washer?—No, that is what the patentee describes, but as it is comparatively open at the top, it is obvious that what he means is really that it is closed so that there shall not be an in and out draught of air at the bottom, so that the communication with the outer air shall be practically all at the top. It is not necessary to close the bottom so as to stand pressure or make it contain water or anything of that sort.

I put this to you—of course, I only put it for my friend to object to it.—I put it to you that the same interpretation of these words "closed airtight," and "a closely fitting feed opening," which justifies you in saying that it is within their claim would equally justify you in saying Beardlee, also, which is before, is within the claim?—I do not remember Beardlee's lamp.

Mr. MOULTON: I object.

His LORDSHIP: I am afraid it is within my former ruling.

Mr. BOUSFIELD: Yes, of course it is, my Lord, if my friend objects to it. It is only to make my point clear.

Cross-examination continued: With regard to Claim 12, the WITNESS said he did not think it chokes in the sense of preserving any pressure inside the globe. The only result of that communication being along through the top of the lamp, would be that you would not get much convection. If the air expanded inside, it would get out perfectly freely, but you would not have draughts in and out.

Mr. BOUSFIELD: Do you say in your view that our envelope is, within the meaning of that claim, an envelope closed on all sides?—Yes; I think so.

Re-examined by Mr. MOULTON: Just tell us what the object of the airtightness at the bottom of the envelope is?—The inside of the

envelope, when the lamp is working, is full of exceedingly hot gas, and if you gave it a chance it would act like a lamp chimney, the cold air would get in at the bottom and the hot air go out at the top, but by closing it at the bottom you prevent any circulation through it.

For that purpose is the lamp of the defendants practically air-tight at the bottom?—I think so, certainly.

Are you speaking of the outer globe?—No, the inner globe.

Is that for the purpose of substantially preventing air passing through?—I do not know what its purpose is, but it does prevent it, and if the grinding is not absolutely true, if you look at that lamp you will find that the top and bottom can move slightly, so as to fit any untruth there may be in the grinding.

So that, aye or no, is that practically airtight?—Yes.

Now with regard to the space at the top, kindly look at page 4 of the specification, the last words before the claims: "The narrow opening before the positive carbon, between the latter and the metallic plug or thimble, permitting egress of heated gases." Does that point to a narrow opening between the carbon and what contains it?—Yes, I think he has no valve there. He wants an opening, and he either has it through a valve or has it round the sides of the carbon.

He says you may have it round the sides of the carbon, or through a valve?—Yes.

Considering that, is the space that there is round the carbon excessive, so as to be out of harmony with the description in the specification?—No, I doubt whether it is as much as is shown in fig. 5.

And if you look at page 3. "In my lamp, however, the enclosure, although practically tight against ingress of air, allows a steady outflow of gases from the lamp." Does that accurately describe what this does?—Yes.

Mr. Bousfield: But that is a reference to the action of the valve?

Mr. Moulton: Yes; but he says at the end that it is instead of the valves.

Mr. Justice Farwell: Yes.

Re-examination continued: The narrow opening had to do what the valve did, or nearly so. They both were amply sufficient to prevent any convection, that is, any gas flowing in and out at the same time.

This ended the examination of the plaintiffs' witnesses, and a long legal discussion followed as to the formal proof of documents.

At this stage the further hearing was adjourned.

On Monday his Lordship gave judgment for the plaintiffs, on the claim for the accounts, and for payment of the royalties and costs. We shall publish Monday's proceedings next week.

*(To be continued.)*

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### City of London Electric Light Company, Limited, v. Mayor, &c., of London.

#### Judgment.

On Thursday, May 3rd, Mr. Justice Farwell delivered judgment in this action. He pointed out that by contracts entered into in 1890 and 1891, the Commissioners of Sewers contracted with the Brush Company for the lighting of certain parts of the City with electricity. Those contracts were subsequently assigned to the present plaintiffs. By an Act of 1897 the whole duties and responsibilities of the Commissioners of Sewers were devolved upon the Mayor, Aldermen, and Corporation of the City. The present question arose on the construction of the City of London Sewers Acts of 1848 and 1851, in which it was set forth that no person being a Commissioner should be, directly or indirectly, interested in any contract entered into with the Commissioners, otherwise the contract would be null and void, and the Commissioner committing the offence would be liable in a penalty of £100 for each offence. It was admitted that at the date of the contract some Commissioners were shareholders in the company. The Court could not set aside an Act of Parliament, even although its application might involve hardship; but if there were two possible constructions, then the Court might adopt the more reasonable of the two. In his opinion the Act contemplated contracts of two sorts, construction contracts, and contracts for supply of—say, water, gas, or otherwise. In his Lordship's opinion, the distinction between the power to enter into construction contracts and the power to contract for the supply of light or water was reasonably plain. But it had been said that the contracts in this case contained clauses which made them construction contracts. In his Lordship's opinion that was not so. The powers were given by provisional orders under certain Electric Lighting Acts. The works connected with the supply remained the property of the plaintiff company, and the contracts were not construction contracts within the meaning of the Sewers Act of 1848. As to a Commissioner being "interested," the Act of 1851 provided that no person being a Commissioner, who was a shareholder in a lighting company, should be eligible to sit or vote as a Commissioner while such a contract was under discussion by the Commissioners. But to say that because a Commissioner was a shareholder, and therefore that the contract was null and void *ab initio*, would be unreasonable. The Commissioners were 91 in number, and the Common Council numbered more; and that argument might mean that if one of them had held a single share in a gas company, the contract with that company might at any moment be voided, and the result might be the absolute prohibition of the use of gas or electric light in the City. Again, assume that a company had spent a large sum in supplying the City with electric light, and it was subsequently discovered that one Councilman had had a single share, should the whole contract be void. As there were two alternative constructions capable of being put upon the Acts, he adopted the reasonable one, and made the declaration asked for by the plaintiff company that the contracts were good. The defendants would be ordered to pay the costs of the action.

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### Chamberlain & Hookham v. the Corporation of Bradford.

In the Chancery Division of the High Courts of Justice on Tuesday, Mr. Justice Farwell commenced the hearing of the action by which the plaintiffs, Messrs. Chamberlain & Hookham, seek to restrain the Mayor and Corporation of Bradford from infringing a patent for electric light meters held by Mr. Hookham, and numbered 4,225 of 1885. Mr. Moulton, Q.C., Mr. A. J. Walter, and Mr. Gray represented the plaintiffs; and Mr. Cripps, Q.C., Mr. Bousfield, Q.C., and Mr. Graham represented the defendant Corporation.

Mr. Moulton, in opening the case, said that the action was brought by the plaintiffs on letters patent, No. *4,225* of 1885 (two stars), which were granted to Mr. George Hookham, and the defendants were the Mayor and Corporation of Bradford. The patent was for an electric meter—that was to say, an instrument which registered the amount of electric energy supplied on an electric lighting circuit to a house, or to any other establishment, which took the place of the gas meter in connection with the electric incandescent light. This patent had stood the test already of an action before Mr. Justice Wills, who supported it, and all the defences conceivable and inconceivable, were raised in the present case, including some which were decided by Mr. Justice Wills. He did not propose, in his opening, to deal particularly with those defences, because he had the certificate of validity already, and he did not know on what particular portions of the defence his learned friends would rely. Many of the points raised were points of law, and on these this Court would follow the decision of a Court of co-ordinate jurisdiction. The patent was for an electric meter to measure the quantity of electric light supplied. Such an instrument was a necessity. Accurate measurement of the electric supply was a condition necessarily precedent to that supply upon a commercial basis. They had to consider what was to be the measure and how it was to be measured. Legislation in connection with electric supply had dealt with force and not with matter for electric sale. Electricity had no substance, weight, shape or size. It was pure force, but not force which always manifested itself in a particular form. For instance, electrical currents might be created to any extent. In the Rucker case the Court went into questions of current and pressure, but the power was indestructible and illimitable. What they had to do was to realise that the measure of power could change its balance, and that the essence of a useful system of supply was, that it should be kept at a uniform pressure, and well-managed companies kept their supply within 1 or 2 per cent. of the proper pressure. What he had to deal with was the measured quantity, and that phrase could be used with accuracy in two totally different senses. In one it had been used by all electricians in every laboratory since electrical science was started—galvanometers, which told the size of the current. But that was not all that was wanted. In measuring the electric supply they wanted to know not only the quantity supplied at one moment, but the total quantity supplied at any given point—not the rate of the current at any moment, but the total effect of a current which was going on for a considerable time; and it was quite clear that the very unit in which they were going to express the matter ought to be defined. "Quantity of electricity" was an idea which, although necessary for theoretical purposes, was most unhandy for practical life, and so they reckoned total quantity of electricity by the current running for an hour, and thereby took the standard of current. They reckoned it by ampere-hours—that was to say, the amount which one ampere would carry along in a whole hour. The ampere-hour, therefore, became their unit of total quantity, and so they could measure the size of a current running for a long time by the ampere-hours. Legislation with regard to electric lighting recognised this by establishing Board of Trade units, which were for 1,000 ampere-hours. So far he had been dealing only with the current, and current told them very little about the amount of supply. Now, the Board of Trade unit was one of 1,000 amperes at 1 volt pressure. He would take it that the standard pressure at which all these systems were worked was 100 volts, so that the Board of Trade unit corresponded to 10 ampere-hours at that pressure. They, therefore, had to measure the quantity supplied in terms of ampere-hours. If they had that, they had an accurate measure of the energy that was passed in, and how were they to do that? By the galvanometer they could measure the advent of the current, but the task of adding up what was done required a totally different class of machine. Edison thought of this idea, but the only practical field was that of constant pressure, and Edison's device worked very fairly, but only as a pioneer idea. There therefore remained a hopeful field for designing a proper meter. He would show the Court a rough model which he had of a dynamo. There was a part which revolved. It was called the armature. There was a magnet between the parts in which it revolved, and they were made a magnet by a coil at the bottom. When a current was passed through that coil, the coil itself became a magnet, and so there had been made a strong horse-shoe magnet. Then there were two little strips of copper resting on the angle of the armature. If these were connected with a source of electric current which would go down them, and then pass the commutator, which was part of the axle, and which was what the little strip of copper touched, then the electric current passed from it round the coils. The effect was to make each of these a magnet, but the wires of the three magnets were so arranged as to make one magnet with its north pole vertical upwards, and then there was the south pole operating with the result that the magnet moved over in order to get into its proper position. There were a north pole and a south pole, which attracted or repelled each other; but no sooner did they move over than the electric current came in by a different door, through a section of the commu-

tator, and the north pole, therefore, was always in a position where it could stop. That was the theory of the dynamo, and the strength with which it could be turned round depended clearly on the magnitude of the current which went into the armature. If they kept the outside magnet quite constant, and measured the twist, and saw how much it was attracted, then they could get an indication of the current at the moment. But still they were as far as ever from measuring the total amount. The next step taken for measuring the amount supplied over a long period was really a plain and simple idea. Suppose they talked about an Atlantic liner driven at 9 miles an hour, they would burn probably about 30 tons of coal a day. If they wanted to go 18 miles an hour, they would burn 300 tons a day. The doubling of the speed would require 10 times the amount of coal. The illustration showed that they could not trust to the distance to indicate the amount of coal consumed; and in electricity the fact that they got something which was bigger when the current was bigger and smaller when the current was smaller, did not show them the amount of the current. It was, therefore, necessary to have a meter, something showing results proportional to the twists. All they needed to look for was something which, at a steady rate, did something in proportion to the current, and the steady rate, or equilibrium rate, was just when it did all that it could, and got the energy from the current to do it. The steady rate was proportional to the twist. People thought of various methods. Sometimes they said they would make the rotating armature paddle in water, because the faster they tried to go, the greater the resistance, and therefore if they doubled the current they would make it go faster, only in proportion to the resistance of the twist. The instrument before his Lordship recorded the total amount of the current. Mr. Hookham was the first person who used the principles in the combination now before the Court in such a manner as to make a practical meter, and that was practically the judgment of Mr. Justice Wills. He (Mr. Moulton) had pleaded on this subject before Mr. Justice Wills with some earnestness, because when he had his first installation at his own house, he had found that his first account was 95 per cent. wrong. But to proceed, the meter ought to start very willingly and with little force, otherwise there would be a supply which would not be recorded, and therefore it would not be accurate. The meter must also rapidly take up its steady rate. There must be little mechanical friction of the pivots, because that would blur the accuracy of the registration. Mr. Hookham early recognised that what they had to do was to increase as far as possible the supremacy of electrical forces, and diminish as far as possible the interfering forces. He was the first to discover how to produce a practical meter of this kind, and the success of it had been very great indeed. His Lordship had before him the meter exactly as it had been drawn in the specification. The principle was still the same. Any changes were changes of detail or of greater perfection of workmanship, and the meters had won for themselves high estimation as exactly accurate registers of the total amount of electricity supplied. He would now have to refer to the provisional specification, because, notwithstanding the decision of Mr. Justice Wills, the question of disconformity was being raised by the defence in this case.

Mr. CRIPPS said he did not raise disconformity in the ordinary sense of the term, but on the construction of Claim 3, and in connection with that, the provisional specification was important.

Mr. MOULTON then read portions of the provisional specification. It was in the name of Mr. George Hookham:—"My invention consists of the improvements hereinafter described in electricity meters, parts of the said improvements being also applicable to dynamo electric generators and motors. My said electricity meter consists essentially of an electro-motor with constant, or nearly constant, field, the armature carrying the current to be metered, and an electric brake, consisting of a mass of metal in the form of a disc cylinder or other figure of rotation rotating in a magnetic field in such a manner as to have 'eddy' or so-called 'Foucault' currents generated in it. When all other work done by the motor is negligible compared with that done against 'eddy' currents, the speed of rotation of its armature is directly proportional to the armature current. The electro-motor may be of any convenient kind or form. It may, for instance, have a drum ring or disc armature." That described the three forms of armature. The drum was invented by Siemens, the ring by Gramme, and it was not exactly known who devised the disc. The disc armature in question was not a drum, it was not a ring, but it was an arrangement of wire put quite flat. (The learned gentleman exhibited the apparatus to the Court.) Resuming, Mr. Moulton said that the specification proceeded to say:—"Or it may consist of a simple solid disc or cylinder rotating between magnetic poles. In the latter case, however, I prefer to use two thicknesses of metal in the disc or cylinder, the one carrying the current to be measured being insulated from the other except near the centre." The electric brake might be formed by the armature itself, or it might be attached to the armature so as to rotate in the same field; or it might be independent of the armature and rotate in a separate field, or a separate brake might be used in addition to an armature brake. Then the specification went on: "In order that other work done by the motor may be very small compared with the work done on the electric brake special means to reduce friction are adopted. If the axis of the motor armature is horizontal the spindle is supported on friction wheels, and if vertical, or nearly vertical, on hardened points, and in both cases I use mercury contacts, or commutators where practicable." He would refer to the commutators upon the complete specification, and his Lordship had before him the actual machine, the first one made, and that which was described in the drawings. (Mr. Swinburne explained to his Lordship the different parts of the machine as Mr. Moulton read about them from the specification.) Mr. Moulton said that after stating the principles of the invention he would now come to the claims. They were, first, "An electricity meter for measuring currents, consisting of an electromotor with constant field arranged substantially as hereinbefore described, the said electromotor being combined with an electric brake, also moving in a constant, or nearly constant field, preferably the same field as that in which the armature rotates, substantially as herein described." That really claimed the type of meter now before the Court, and so it had been held by Mr. Justice Wills. The plaintiffs alleged the infringement by the defendants of the claim, and of the third claim which was "In electricity meters the use, for the purpose of procuring a powerful and constant magnetic field, of permanent magnets, with very large polar surfaces, closely fronting each other, so to form a narrow slit in which the disc armature revolves whether the same be magnetised in position or otherwise, and the means described for regulating the same when, or, if necessary, substantially as herein described." As to disconformity that only turned on the question of whether a man had put in a claim for one invention and produced another. But a man had time to improve upon the claim that he put in originally. He had nine months during which to work out and improve upon what he claimed in his provisional specification. The provisional specification was merely a kind of enlarged title. The title improvements in electricity meters might have become to be too vague, and something more definite might be wanted. The defendants said that if having got this specification, anyone went over the field of electrical literature and picked out a bit here and a bit there and a bit elsewhere, they might find possibly that people had previously held the ideas of Mr. Hookham. Well, that was very likely. But Mr. Hookham was the first to make a practical affair of this meter, and he had rightly claimed it. The Bradford Corporation in their character as electric lighters, were the defendants in this case, and he would produce now to his Lordship one of the meters which they used. It looked very different from that of the plaintiffs. They had chosen the arrangement in which the current went through the field instead of the armature, and they might have an armature which had a constant current. (Mr. Swinburne here again mounted to the bench and explained the apparatus to his Lordship.) Mr. Moulton, continuing, said that what the Bradford Corporation had done was that they had taken the vertical spindle which his patent claimed. Their disc was revolving between the poles of two permanent magnets with large polar ends close together. The plaintiffs said that the Bradford Corporation instrument infringed both the first and the third claims for large and permanent magnets. Mr. Justice Wills had realised that Hookham was the first person to make a meter of this kind, that he was justified in claiming it, and although the question was very different, it was only a variant—only taking one of the alternatives, just as, in this case, the defendants were taking one of the alternatives set out in the specification.

Mr. Justice FARWELL: But how far can you monopolise principles which are known?

Mr. MOULTON said they could not do so; but if one took certain principles and made a practical meter, then he could claim for that, and within that claim he was entitled to prevent another from infringing.

Evidence was then called.

Mr. GEORGE HOOKHAM, examined by Mr. WALTER, said he had devoted a good deal of time to the study of electricity, and he was the patentee of "4,225" of 1887, relating to this electric meter. At the time of his taking out that patent there were only two practical meters in use, or on the market. So far as he knew there was no meter of the character described in his specification. So far as the constancy of the field was concerned, it was necessary, in an electrical meter, that some portion of the apparatus should be constant. Examined as to the description of the drawings, the witness stated that the meter which was before his Lordship (G.H. 2) was constructed in accordance with the drawings in the specification. That was one of the first meters constructed by him. The drawings were made from such a meter. (The witness pointed out and explained to his Lordship the different portions and other devices of the machine.) In order that the apparatus should meter correctly the field or armature had to be constant. In the apparatus in question whether constancy could be maintained depended upon the whole construction of the magnetic circuit. He found when he came to work on the subject that he could get a powerful field with steel which was absolutely permanent. It was necessary to have a practically closed magnetic circuit.

Mr. WALTER: May I put it that until you pointed out the conditions of a powerful permanent magnet such things had never before been made?—So far as I know they had not been made before, nor the possibility of them believed in.

It is alleged that the specification is insufficient to enable a person to produce the required result. What is your view?—I think it is perfectly sufficient.

Examination continued: He had sold a considerable number of the meters in the actual form described in the specification. So far as he knew they gave satisfaction as meters of electricity. He did not think he had submitted that form of meter to the Board of Trade.

Mr. WALTER: It is suggested that your invention is not new. So far as you know is your invention as described in the specification new at that date?—Yes, so far as I know.

What is the nature of the current supplied upon the Bradford circuits?—It is continuous or direct current of 230 voltage. It is, I think, something between 200 and 250, but I am not sure.

The WITNESS stated that he was not able to draw any distinction between the apparatus found in "G.H. 4" and that described in his specification.

Cross-examined by Mr. CRIPPS: On the circuit such as at Bradford it made no difference whether it was a current meter or an energy meter.

Mr. CRIPPS: Where you have a current meter, it is specially designed not to take any notice of change of pressure?—On no; it

is not specially designed for that. It is designed on the assumption that changes of pressure need not be taken any notice of.

Cross-examination continued: It was not quite true to say that if the potential varied at any time his current meter would not chronicle it in any way. The object of the energy meter was to chronicle differences in pressure as well as differences in current, whereas his meter chronicled current only. In order to have a correct current meter it was necessary to have an electromotor with constant, or nearly constant, field.

Assuming you want to measure variations in energy, it would be destructive to that to have an electromotor with constant, or nearly constant, field?—The WITNESS said that would be so.

The WITNESS, continuing, said that he did not claim to have discovered eddy currents or the saturation of the magnets. He did discover how to make a powerful and constant magnet. In 1887 Witness took out a specification for an energy meter. It was subsequent to his specification for a current meter.

Mr. CRIPPS: Supposing the electromotive forces did not vary, the only force they had to measure was the current force. But if you wanted to measure the electromotive force the defendants' meter would do it and yours would not?—Yes, that is so.

Cross-examination continued: The defendants only passed the shunt current through the commutator, and Witness passed the whole current. He had permanent magnets. It was necessary to have the magnets powerful. The same form of magnet would be powerful whether it was applied to the motor or the brake. It depended upon the shape of the armature and the shape of the brake. In his case he had the armature and brake moving in the same field.

Is not the form of magnet which you refer to in your specification the form known as the built-up or compound magnet?—I am not familiar with those names.

Cross-examination continued: What he referred to was a magnet with added pole-pieces.

*(To be continued.)*

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FRANKENBURG *v.* D. MOSELEY & SONS.

IN the Chancery Division on 3rd inst. the case of Frankenburg *v.* D. Moseley & Sons was before Mr. Justice Farwell. The plaintiff sought to restrain defendants by injunction from an alleged infringement of his patent relating to improvements in the manufacture of india-rubber. The defence was a denial of the infringement. Both parties carry on business in Manchester.

Mr. FLETCHER MOULTON, Q.C., when the case was called, rose and said he was happy to tell his Lordship that the parties had approached each other, with the result that his Lordship would not be troubled with the case. The action would, therefore, be withdrawn simply on terms.

Mr. CRIPPS, Q.C., said he was on the other side, and he confirmed the statement of his learned friend.

The action was withdrawn accordingly on terms not disclosed.

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## BUSINESS NOTES.

**American Trade in the East.**—We read in a New York Exchange that Mr. O. H. Kirk, of the Westinghouse Electric and Manufacturing Company, has started for Kobe, Japan, where he will establish himself as the representative of the company in the Far East, Siberia, Corea, China, and the Philippines, are included in Mr. Kirk's territory. The enterprise which is being shown by American electrical manufacturers at the present time in seeking to extend their connection, and capture practically untilled ground, should make many an English firm seriously consider its ways. Far be it from us to shriek as some have done, that our national industries are rapidly going to our competitors, but it appears that if we are to maintain our hold effectively upon our existing markets, and to find our way into new ones, we must be prepared to run equal risks with our competitors. Works may be full of orders at the present moment, but it does not follow that they always will be. We must see that our rivals do not outdo us in the amount of push and go that we put into things. There is certainly room for a greater effort on the part of English manufacturers. We suppose the responsibility shifts from shoulder to shoulder and no one manufacturer takes it home to himself. If that be so, it is deeply deplorable, and calls for a little more heart-searching.

**Books Received.**—"Elementary Lessons in Electricity and Magnetism," by Silvanus P. Thompson. London: Macmillan and Co. 4s. 6d.

Nos. 44 and 47, "Fire Tests with Partitions." No. 46, "Two Fire Tests with Fire Resisting Curtains," and No. 48, "Fire Tests with Floors." London: The British Fire Prevention Committee, 1900. Each, 2s. 6d. net.

**Charge of Embezzlement.**—J. Aylieff was remanded at Ashton Police Court last week on a charge, to which he pleaded guilty, of embezzling £400, the money of his employer, P. B. Wilson, of the British Electric Works Company.

**Oppermann Automobiles.**—We are informed that Sir Howard and Lady Vincent have engaged an Oppermann electrical Victoria for the season.

## Electrical Wares Exported.

**WEEK ENDING MAY 2ND, 1899.**

| | |
|---|---|
| Adelaide | Value £280 |
| Amsterdam | 71 |
| Auckland | 99 |
| Bahia. Teleg. cable | 19,567 |
| Bangkok | 10 |
| Boulogne | 51 |
| Buenos Ayres | 2,018 |
| " Teleg. mat. | 320 |
| Calcutta | 648 |
| Cape Town | 535 |
| Colombo | 61 |
| Durban | 340 |
| East London | 111 |
| Gibraltar | 17 |
| Gothenburg | 92 |
| Halifax | 589 |
| Hamburg | 150 |
| Hong Kong | 364 |
| Melbourne | 174 |
| " Teleg. mat. | 640 |
| Montreal. Teleg. wire | 58 |
| New York | 137 |
| Odessa. Teleg. mat. | 30 |
| Piræus | 188 |
| Port Elizabeth | 151 |
| Port Said | 8 |
| Stockholm. Teleg. mat. | 273 |
| Sydney | 365 |
| Teneriffe | 25 |
| Vladivostock | 130 |
| Total | £27,497 |

**WEEK ENDING MAY 1ST, 1900.**

| | |
|---|---|
| Adelaide | Value £61 |
| Alexandria | 134 |
| " Teleg. mat. | 45 |
| Amsterdam | 85 |
| Boca. Teleg. mat. | 425 |
| Bombay | 195 |
| Brisbane | 128 |
| Brussels | 34 |
| Buenos Ayres | 75 |
| " Teleg. mat. | 150 |
| Calcutta | 714 |
| Cape Town | 1,264 |
| " Teleg. mat. | 4,100 |
| Chinde | 54 |
| Colombo | 51 |
| " Teleg. cable | 708 |
| Durban | 284 |
| East London | 19 |
| Hamburg | 220 |
| " Teleg. mat. | 500 |
| Havre | 100 |
| Hong Kong | 879 |
| Kobe | 91 |
| Malta | 140 |
| Melbourne | 159 |
| " Teleph. mat. | 1,131 |
| Ostend | 90 |
| Penang. Teleg. instruments | 108 |
| Port Elizabeth | 64 |
| Rio Janeiro. Teleg. mat. | 56 |
| Rosario. Teleg. apprts. | 198 |
| Shanghai | 302 |
| " 24 tons old teleg. wire | — |
| Singapore | 71 |
| " Teleg. mat. | 541 |
| Stettin | 60 |
| Sydney | 987 |
| Townsville | 763 |
| Wellington | 726 |
| Yokohama | 818 |
| Total | £15,859 |

## Foreign Goods Transhipped.

| | |
|---|---|
| Flushing. Elec. apparatus | Value £15 |
| Stockholm. Teleg. mat. | 20 |
| Total | £35 |

| | |
|---|---|
| Fremantle. Teleg. mat. | Value £50 |
| Perth. Elec. mat. | 308 |
| Total | £358 |

## Electrical Wares Exported.

**WEEK ENDING MAY 9TH, 1899.**

| | |
|---|---|
| Aden | Value £88 |
| Alexandria | 50 |
| Amsterdam | 50 |
| Antwerp | 340 |
| Batoum | 11 |
| Beira. Teleph. mat. | 114 |
| Bombay | 243 |
| Buenos Ayres | 356 |
| Calcutta | 249 |
| Colombo | 35 |
| Copenhagen | 107 |
| " Teleg. cable | 227 |
| Durban | 1,186 |
| " Teleg. mat. | 286 |
| East London | 1,002 |
| Fremantle | 277 |
| Gibraltar | 18 |
| Hong Kong | 10 |
| Madras | 15 |
| Melbourne | 117 |
| " Teleg. mat. | 248 |
| Perth | 245 |
| Port Elizabeth | 60 |
| Rio Janeiro. Teleg. mat. | 56 |
| Rotterdam. Teleg. mat. | 246 |
| Santos | 257 |
| Shanghai | 15 |
| Singapore | 97 |
| Sydney | 1,826 |
| Townsville | 1,106 |
| Vladivostock | 90 |
| Wellington | 116 |
| " Teleg. mat. | 167 |
| Yokohama | 1,050 |
| Total | £10,200 |

**WEEK ENDING MAY 8TH, 1900.**

| | |
|---|---|
| Amsterdam | Value £280 |
| Bombay | 180 |
| Calcutta | 760 |
| " Teleg. mat. | 317 |
| Cape Town | 554 |
| Colombo. Teleg. mat. | 16 |
| Durban | 567 |
| " Teleg. plant | 5,946 |
| Gibraltar | 20 |
| Gothenburg | 25 |
| Hamburg | 27 |
| Hong Kong | 84 |
| Kobe. Teleph. mat. | 659 |
| Madras | 809 |
| Nagasaki | 127 |
| New York | 355 |
| Ostend | 8 |
| Port Darwin. Teleg. mat. | 80 |
| Rouen | 105 |
| Shanghai | 121 |
| Singapore | 90 |
| Wellington | 51 |
| Total | £11,181 |

## Foreign Goods Transhipped.

Perth. Elecl. machinery. Value £900

**Catalogues and Lists.**—Messrs. Joseph Adamson & Co., of Hyde, send us a copy of their revised list of flanging steel boiler end plates, also a list of blocks for dishing plates, and particulars of manholes, &c.

From the St. Helens Cable Company, we have received a circular letter stating that their October, 1899, price list for vulcanised rubber and "Impregnable" paper cables still holds good; also a new list of mechanical and other rubber goods. The company is placing upon the market the "N. jointing tape, for vulcanised rubber or paper cables," which, though consisting of pure rubber and pigments, has, we read, been prepared in such a manner that the same is "absolutely indestructible" when put on the cable. This new "N." tape is ready for use, and can be put on to the joints either with or without pure rubber tape being used direct on the conductor, without rubber solution, except for holding down the ends. It is guaranteed not to attack either plain or tinned copper, and is waterproof and indestructible. The company also supplies the trade with special combined paper and rubber floor covering for generating stations and sub-stations.

The B.T.H. Co.'s pamphlet, No. 62, deals with quick-break switches.

A new catalogue has been issued by Messrs. Pryke & Palmer, of Upper Thames Street, E.C., in which they describe their conduit

system of wiring for electric light, bells, telephones, &c. The makers claim to be pioneers in conduit wiring; their fire-proof and water-tight system of wiring in iron tubes—a main feature of which is the adoption of Russell's special joint boxes—having been brought before the trade some years ago. They claim also that the system has been appreciated by Fire Insurance offices, and largely used in the electrical trade. The list contains illustrations and prices of all the various parts for a complete system.

From the British Electric Works Company, Limited, we have received an advance electrical list, in which the "Stellite" switches, lamp-holders, wall-plugs, counter-weights, and other fittings of the kind are illustrated and priced.

An excellent catalogue of electric light fittings, including some very artistic designs of electroliers, table and floor standards, pendants, &c., comes to hand from Messrs. James Hinks & Son, Limited, of Birmingham and London.

An illustrated list of motor rheostats and dynamo field regulators comes to hand from the General Electric Company, Limited.

The Hart Accumulator Co. send us a hanging show card with illustrations of their accumulators showing the patent grid and non-corrosive terminal.

The Edison & Swan Company sends us one of its "Ediswan" blotters, which is made-up of a set of incandescent lamp lists interleaved with blotting.

The Simplex Steel Conduit Company, Limited, of Birmingham, has, in connection with its Paris Exhibition exhibit, prepared a list of some of the more important electric light installations where the Simplex conduit system has been erected, wholly or in part, during 1899 and 1900. The booklet also contains a large number of testimonials recently received from consulting engineers and contractors, showing the wide application of the Simplex system and the favour with which it is received.

We have received from the Canadian Motor Company, of Toronto, Canada, a set of sheets giving illustrations and particulars of the Canadian electric vehicles on the "Still" system. The advantages of electromobilism are detailed, and prices of the Still carriages are given.

A handy draughtsman's rule comes to hand from the General Electric Company, Limited, upon which, in addition to inch and metric scales, are printed a large number of data regarding weights and measures, rates of exchange, and handy symbols. We are informed that these are to be supplied free to the trade on application; but the supply is limited.

We have received from the Bullock Electric Manufacturing Company, of Cincinnati, O, Bulletin No. 34A, containing illustrated particulars of railway, light, and power generators, and parts thereof; also efficiency curve. Bulletin No. 36 is devoted to marine lighting and power sets. Both pamphlets bear date, March, 1900.

**The Charge of Incendiarism Dismissed.**—At the London Central Criminal Court on Saturday last week, in the case of Christian Maddock, 30, who was indicted for attempting to set fire to a pattern store belonging to the India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited, at Silvertown, with intent to injure.

Mr. Guy Stephenson appeared for the defence at the request of Mr. Justice Lawrance, and moved to quash the indictment. The facts set out in the indictment were that the prisoner placed on the inflammable wooden floor of the pattern store wooden pattern blocks covered with cotton waste, that he saturated them and the surrounding floor with methylated spirits, and placed a freshly-trimmed but unlighted candle in the midst. He argued that the acts done by the prisoner might have been a preparation to commit the offence, but that they did not amount to an attempt. The last act depending upon the prisoner must be done in order to constitute an attempt.

Mr. R. D. Muir, who appeared for the prosecution, said it had never been decided by any case that the act penultimate to the commission of the full crime was necessary to constitute an attempt to commit that crime. In the case of the "Queen *v.* Eagleton" (Dearsley, 515) the accused had committed the penultimate act, but in the case of "The Queen *v.* Roberts" (Dearsley, 539) several acts remained to be done before the full crime could be committed. All that was necessary to constitute an attempt was that the act done should be sufficiently proximate to the commission of the crime to manifest clearly what the intention was. In this case the prisoner's intention was clearly manifest by his acts.

Mr. Justice Lawrance said that in this case he thought the indictment must be quashed. He was of opinion that as something remained to be done by the prisoner, and as there was no interruption, that which the prisoner did, did not amount in law to an attempt. He accordingly quashed the indictment.

Mr. Muir asked his Lordship to state a case on the point.

Mr. Justice Lawrance replied that if he had any doubt on the point he would state a case; but he had no doubt whatever about it, and he must therefore decline to do so.

**The Chinese Ambassador at Wolverhampton.**—The Chinese Ambassador was the guest of the Mayor of Wolverhampton on Monday. In the afternoon His Excellency visited the electric works of Messrs. Thomas Parker, Limited, where he was received by Mr. T. Parker and Ald. C. T. Mander (the chairman of the company).

**The Copper Market in April.**—The last issue of Messrs. H. R. Merton & Co.'s statistical circular shows that during April the supplies have totalled 27,155 tons, while deliveries have amounted to 23,413 tons, and in addition 899 tons "Standard" have been shipped to America. Stocks have therefore increased from 24,632 tons at the commencement of the month to 27,475 tons at the end of the month, and prices have given way £1 17s. 6d. per ton. The great increase in supplies is due wholly to the shipments from North America, which have risen to 18 289 tons, a total 8,000 tons above the average for the preceding 12 months. The shipments from Chili and from Spain and Portugal, are only little above the average; while the shipments from Australia and from miscellaneous countries are below it. The stocks of copper in English and French ports, or afloat thereto, are now nearly equal to the stocks on September 30th last. The following figures show the stocks and prices on the last day of each month since May, 1899:—

| Date. | Stock. | Price G.M.B's. |
|---|---|---|
| May 31st, 1899 ... ... | 30,156 tons. ... ... | £76 15 0 |
| June 30th, „ ... ... | 29,004 „ ... ... | 76 15 0 |
| July 31st, „ ... ... | 33,019 „ ... ... | 76 5 0 |
| Aug. 31st, „ ... ... | 32,389 „ ... ... | 76 15 0 |
| Sept 30th, „ ... ... | 28 328 „ ... ... | 75 15 0 |
| Oct. 31st, „ ... ... | 26 804 „ ... ... | 72 17 6 |
| Nov. 30th, „ ... ... | 25,765 „ ... ... | 73 15 0 |
| Dec. 31st, „ ... ... | 24,817 „ ... ... | 70 0 0 |
| Jan. 31st, 1900. ... ... | 21 327 „ ... ... | 71 5 0 |
| Feb. 28th, „ ... ... | 22,982 „ ... ... | 74 15 0 |
| Mar. 31st, „ ... ... | 24 632 „ ... ... | 78 12 6 |
| April 30th, „ ... ... | 27,475 „ ... ... | 76 15 0 |

**Electrically Controlled Public Clocks.**—The Glasgow Corporation has resolved that an experimental installation of five or six of Prof. Becker's new electrically controlled clocks, to be controlled from the Observatory, be fitted up in the western district of the city. The cost will not exceed £50.

**Fire Tests.**—Some tests were made by the British Fire Prevention Committee last week in connection with "non-flammable" wood, the object being primarily to show whether the treated wood would spread or sustain flame, the duration of the investigation being 45 minutes. The report of the Committee will be shortly issued and should be of particular interest, as the trials were made on a comparative basis, and with so-called match-boarded partitions. The attendance of members and visitors was naturally very large, including many of the Government and municipal officials, as well as the representatives of the great insurance companies.

**For Sale.**—The Tunbridge Wells Corporation wants offers for its electricity works switchboard. See "Official Notices" to-day for particulars.

**Isle of Man Tramways.**—In the Manx High Court on Monday, several suits against the Isle of Man Tramways and Electric Power Company were called, but, with one exception, were withdrawn, including one by the Douglas Corporation to recover a large sum in respect to royalties on receipts of the Douglas Bay Tramway. In the suit of William L. Knowles, late engineer to the company, to recover £1,183 salary and commission, Mr. Browne, for the company, admitted £33 in respect of salary, and said the company had been and were willing to pay the amount, any time. As to the claim for £1,150 commission, at 1½ per cent., on the cost of the construction of the Ramsey section of tramways, he asked for particulars, and said there was never any agreement to pay any commission. The matter was continued.

**Liquidation.**—The Howell's "Simplex" Anti-Inductive Telephone Syndicate, is winding up voluntarily. Mr. D. F. Basden, 33, St. Swithin's Lane, E.C, has been appointed liquidator.

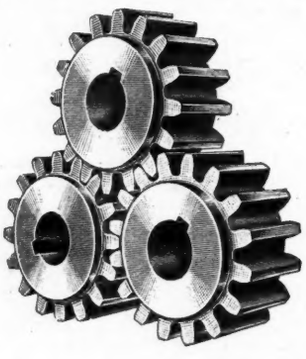
**The Monobloc Accumulator.**—We have received from Messrs. Drake & Gorham, sole agents in the United Kingdom for the Monobloc Accumulator Syndicate, Limited, a catalogue giving particulars and prices of the Monobloc Accumulator, known on the Continent as the "New Julien." References are given therein to tramway systems abroad fitted with this type of cell, and at the end of the catalogue we notice the results of various tests and trials to which the cells have been subjected by Continental accumulator experts. We are informed that special plant has been installed at Bakewell, Derbyshire, for their manufacture on an extensive scale, and in view of the important part which accumulators under certain conditions are destined to play in electric traction, there is no doubt of a steady and increasing demand for the Monobloc. In brief, it may be stated that the block of the positive material is composed of punched sheets of corrugated lead, built up from the bottom of the cell so as to form one homogeneous mass, which is cross-tied at all points to give the maximum mechanical strength; the corners of the block are of solid lead, to which the separate layers are autogenously welded. The holes punched in the horizontal sheets form a cellular casing and receptacle for the negative electrodes, which are in the form of vertical pencils, provided with collars at intervals of about 1 inch to retain the spongy lead in place. The positives are formed on the Planté system, while the negatives are pasted. Owing to the cellular construction of the positive block, buckling appears to us to be practically impossible, while the horizontal lamination affords the best means of retaining the active material in place. The negative rods are surrounded by perforated ebonite tubes and stand on insulating feet, while insulating rings at the top and bottom prevent them from touching the positive. The cells are usually made up in ebonite boxes, and are manufactured in sizes ranging from 33 ampere-hour capacity, weighing 10 lbs., to 800 ampere-hours, weighing 300 lbs. The tramway services at Ghent and Dunkirk have been conducted entirely with Monobloc cells for over a year, with satisfactory results; at Ghent there are 36 cars in regular work, and 11 spare, each carrying 108 cells in 12 boxes, and running 50—60 km. with one charge, though 78 km. has been attained. Each car weighs 5,740 kg. The elements are removed for cleaning after a run of 6,000 km.; but no cell had been renewed at the end of

Victoria for the season.



eight months' working, during which each cell had run 23,000 km. Seeing that the only test of a storage cell for traction that can be relied upon is the test of actual operation over long periods, the results obtained on these lines seem to augur well for the future career of the Monobloc accumulator.

**Noiseless Gears.**—One of our representatives has had the pleasure of inspecting gears manufactured by the Buffoline Noiseless Gear Company at their works at Levenshulme, near Manchester. The samples submitted were carefully made and seemed well suited for durability. The wheels are cut with the involute form of tooth unless otherwise ordered, and are made in every form which a toothed wheel may require, spur, bevel, and single or double helical. The makers claim that owing to the process which they use, these wheels



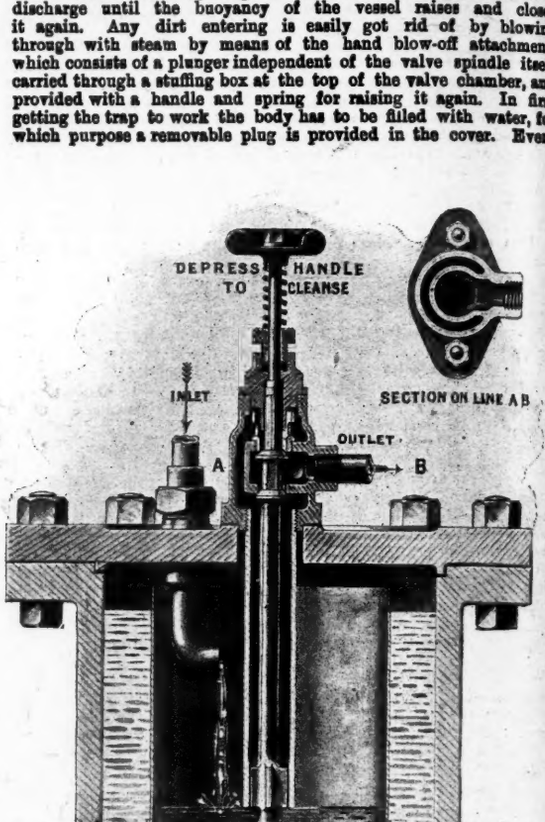
are more than twice as strong as cast-iron, while in weight, noiselessness, and absence of necessity for lubrication, great advantage is obtainable. The wheels are specially suitable for motors, pumps, cranes, and motor cars. The company are using, at present, for their circulars and advertisement, a reproduction of a photograph of their 11-foot wheel, with a man standing beside and a little behind it. The company make a speciality of the manufacture of spur wheels up to 11 feet diameter with machine-cut teeth.

**Patent Fire Bridge.**—Our attention has been drawn to patent No. 4,910, A.D. 1899, of one John Alves, of 131, William Street, Melbourne, in the colony of Victoria. It is for a fire bridge, and a method of supplying steam so as to convert the fire into a Bunsen burner to generate intense heat, and to prevent smoke. We have nothing to say against the principles which are sought or utilised by the patentee, but we are informed that a company with £300,000 of capital is being formed to exploit the patent. Briefly described, the bridge is of cast-iron with vertical apertures. Horizontally behind the bridge is a steam pipe provided with jets behind the apertures. The jets no doubt largely assist the indraught of air. Probably an intense heat may be generated by their action, and much good may be done in connection with the over-bridge of brick in the way of preventing smoke. It is quite likely that the heat may melt the bridge, and perhaps run the brick arch into liquid. It is possible that Mr. Alves may even believe his idea is worth £300,000 of the public's money. All these things though probable or possible, are not so certain as that the same results can be obtained by a hundred different methods that do not involve the expenditure on a "patent" of £300,000 or even 300 pence. The value of anything good in it lies chiefly in the brick arch part of the arrangement, and we feel bound to speak well of this. It embodies the principles of combustion which we have steadily and frequently advocated, and if anyone is to obtain £300,000 for brick arches, we feel ourselves to have a prior claim to Mr. Alves, and we feel safe in making this claim, because the first users of brick arches for this purpose were probably many years dead before we were in our cradles, and they are therefore conveniently out of our way!

**Switzerland.**—A Milan syndicate has applied to the authorities of Bellinzona, Switzerland, for a concession to utilise the water power of Lake Ritorn near Ariolo. It is stated that 14,000 H.P. would be available, and that it is intended to establish large works for the generation of electric energy and for the manufacture of caustic soda.

**Trade Announcement.**—Mr. Henry Adams announces that he has taken Mr. Hal. Williams into partnership. The firm will be known as Adams & Williams, consulting engineers and surveyors, 60, Queen Victoria Street, E.C. Mr. Williams has until recently been principal assistant to Messrs. Bramwell & Harris. The firm will devote special attention to electric power work in factories and workshops, electric lighting and traction installations, and general civil electrical and mechanical engineering.

**The Tunley Steam Trap.**—We illustrate below the Tunley steam trap. It shows clearly the form of construction of the trap, which works on the float principle, but the patentees have abandoned the levers and joints so common in traps of this type and have reduced the working parts to the simplest possible form. The floating receiver is connected direct with the valve and moves up and down with it; the valve being balanced is independent of variations in steam pressure. We understand that there is practically no friction, as there are no rubbing surfaces beyond the guides at the lower end of the valve stem, which are a loose fit. It may be noted that it is practically impossible for any steam to pass as the outlet is by means of a vertical tube round the valve spindle, the lower end of this tube being always sealed by water in the receiver. The action is as follows: Water enters through the pipe shown and drops into the floating receiver, causing it to fall as soon as its buoyancy has been overcome, thus opening the valve and allowing the water to discharge until the buoyancy of the vessel raises and closes it again. Any dirt entering is easily got rid of by blowing through with steam by means of the hand blow-off attachment, which consists of a plunger independent of the valve spindle itself carried through a stuffing box at the top of the valve chamber, and provided with a handle and spring for raising it again. In first getting the trap to work the body has to be filled with water, for which purpose a removable plug is provided in the cover. Every




care is taken in manufacturing these traps, each one being tested by hydraulic pressure to 400 lbs. per square inch, and with live steam up to 200 lbs. pressure before leaving the maker's works. In order to be in strict accordance with modern practice, these traps are supplied with cast-steel bodies where required for extra high pressures, but for every day pressures up to 200 lbs. per square inch, the cast-iron bodies with which the traps are provided in the ordinary way are found to be perfectly reliable. Both the valve and its seatings are renewable in the latest pattern, and can be got at with the utmost facility. These traps are being manufactured by Messrs. Fletcher Brothers, of Ashton-under-Lyne, under license from the patentees, Messrs. A. E. and J. P. Jackson, and we are informed that they are meeting with a ready sale.

**Typewriting Telegraphy.**—The Typewriting Telegraph Corporation, Limited, has been formed to acquire the patent rights in respect of certain improvements in telegraph recording instruments invented by Mr. W. S. Steljes, a former electrical mechanician in H.M. Post Office, and the prospectus will shortly be issued to the public. Among other users of the apparatus are the Post Office and the National Telephone Company. The capital of the Corporation has been fixed at £100,000, in ordinary shares of £1 each. Sir James Fergusson, M.P., will be the chairman, and Mr. C. E. Spagnoletti will act as consulting engineer.

## ELECTRIC LIGHT AND POWER NOTES.

**Arbroath.**—The Corporation has appointed Mr. M. Buchan, of Edinburgh, to report on an electric lighting scheme for the burgh.

**Asylum Lighting.**—The new asylum which is to be erected at Napsbury, at a cost of £360,000, on behalf of the Middlesex County Council, is to be lighted by electricity. The matter is now in the hands of Mr. W. H. Massey, the consulting engineer to the Council.

**Barmouth.**—The Board of Trade has approved of the application of the District Council for an order for the electric lighting of the town.

**Barrow-in-Furness.**—The Town Council has resolved to enter into an agreement with the British Electric Traction Company for the supply of electric power to the tramways.

**Bexhill.**—The Corporation electricity supply was switched on for the first time last week. The works contain two of Messrs. Hornsby & Sons latest type of water-tube boilers, two 150-H.P. engines by Messrs. Allen, Son & Co., running at 400 revolutions per minute, coupled to 440-volt dynamos, and a battery of 238 accumulators. There are about 6,000 lamps already connected. Mr. W. T. Le Feuvre is the resident engineer, assisted by Mr. R. Carr.

**Bradford.**—The Electricity Committee of the Corporation has decided to fix the charge for electricity for motive power for continuous user through the working hours of the day at 1d. per unit, and for intermittent user at 2d. per unit.

**Brighton.**—Out of 44 candidates the Town Council has appointed Mr. J. Christie, formerly resident electrical engineer to the Glasgow Corporation, to the post of resident electrical engineer and manager of the Brighton Corporation electricity works, under Mr. Wright, at a salary of £400 a year, rising by increments of £25 a year to £500.

**Colwyn Bay.**—The Electric Lighting Committee of the District Council has approved of the scheme prepared by Messrs. Lacey, Clirehugh & Sillar for lighting some of the principal streets by arc lamps.

**Dublin.**—The Clontarf and Pembroke District Councils have withdrawn their opposition to the Dublin Electric Lighting Bill.

**East Grinstead.**—The District Council is considering the advisability of obtaining powers for electric lighting.

**Eastbourne.**—The Town Council has decided to expend the sum of £33,562 upon the erection of a new generating station at Roselands, and the transference of the existing plant to this site, in accordance with a report by Mr. W. C. C. Hawtayne.

**Germany.**—The municipal authorities of Kiel have just decided on the construction of a central electric lighting station in the town at an estimated cost of £35,000.

**Hales Owen.**—The Town Council has decided to apply to the Board of Trade for a provisional order for electric traction. The Council already possesses electric lighting powers.

**Henley.**—The Town Council has deferred the question of electricity supply for 12 months.

**Leith.**—The Electric Light Committee of the Town Council has communicated with Mr. Bryson, accepting his resignation, and regretting that it cannot in the meantime retain his services as consulting engineer. It has further decided to advertise for an electrical engineer, at a salary of £250 per annum.

The accounts of the electricity department for the past year show a total output of 235,985 units, of which 123,394 was devoted to public lighting. The expenses amounted to £2,348, and the receipts to £3,371, but in order to cover capital and sinking fund charges £1,000 had to be drawn from the rates.

**Llanelly.**—The District Council has resolved to obtain powers from the Board of Trade to acquire the Llanelly Tramways Company's undertaking, under an arrangement with the British Insulated Wire Company, which has agreed to provide electric light and traction for the town and district.

**London.**—ISLINGTON.—The Vestry at the last meeting received a report from the Electric Lighting Committee stating that additional transformers were required for the purpose of meeting the demand for light in the district now supplied. On the recommendation of the Committee, the Vestry resolved to order 25 transformers, at a cost of £4,125, on obtaining the sanction of the London County Council to the borrowing of the money. The Committee reported having considered the Electric Lighting Act, 1882, Amendment Bill, which proposes to enable any local or other public authority having the control of bridges to alter the position of electric lines or works during necessary repairs to such bridges without being liable to compensate the electric lighting undertakers for any loss or injury. As the Vestry is the undertaker in Islington, and as the Committee did not apprehend much difficulty, even if the Bill should pass, they recommended that no action should be taken in the matter. The consideration of the recommendation was, however, adjourned.

ELECTRIC LIGHT FAILURES.—The London County Council has given formal notice of its intention to appeal against Mr. Paul Taylor's recent dismissal of proceedings against the London Electric Supply Corporation, Limited.

At Greenwich, on Friday last, Mr. Kennedy gave judgment in the case in which Mr. Shaddick, of the Dover Castle, Deptford, summoned the London Electric Supply Corporation for failure to supply electrical energy to his premises. The summonses were seven in number. Mr. T. W. Marchant attended for the complainants. When the case was before the Court on April 24th the default was admitted. The defence of *force majeure* was raised; but Mr. Kennedy held that it did not apply. In his judgment his Worship said he rested his decision chiefly upon their taking Mr. Shaddick as a new customer when they knew that it was doubtful whether they could adequately supply him with the electric light. The penalty was singularly inadequate, and therefore he must inflict the full penalty of 40s. in each of the seven cases, with 20 guineas costs in the first case and 2s. costs in each of the others, making £35 12s. in all.

HAMPSTEAD.—The Vestry has accepted the terms of the London County Council for a loan of £90,740 for electric lighting purposes.

MARYLEBONE.—The Metropolitan Electric Supply Company has made a deduction of 10 per cent. from the Vestry's account for electrical energy for the last quarter, in respect of failures of supply, and has made similar allowances to private consumers.

MILE END.—The Vestry has resolved that, the Board of Trade having approved of its provisional order, the County of London and Brush Company's plans be rejected. How this decision can possibly be justified, seeing that the plans are admitted to be in order, it is difficult to understand.

**Mexboro'.**—Mr. H. Waring, of Burton-on-Trent, has been appointed electrical engineer for the new electric lighting scheme of the District Council.

**Newport.**—The accounts of the Corporation electricity department show that 31,273 8-C.P. lamps are now connected, as compared with 24,707 at this time last year, and the total revenue for the past year was £2,711, as against £2,028 for the previous year. The cost of generation and distribution was 2·15d. per unit.

**Redditch.**—Mr. E. A. Sandford Fawcett, M.Inst.C.E., Local Government Board Inspector, conducted an inquiry at Redditch last week into an application by the Urban District Council for sanction to borrow £8,000 for purposes of electric lighting. The clerk stated that the need for making this application so soon after the previous loan of £10,911 had arisen from excess of expenditure over the former loan and the success of the undertaking, which had exceeded anticipation. There was no opposition.

**River Shannon.**—The owners of railway boats and barges on the river have lodged a petition against the Shannon Power Bill.

**St. Boswell's.**—The Roxburghshire County Council has declined to consent to an application for a provisional order for electricity supply at St. Boswell's, because "the clerk was of opinion that it would not be wise or safe for the Council to involve themselves in connection with electric lighting schemes until these were on a more satisfactory footing!"

**Salford.**—A special meeting of the Salford Town Council was held on Monday, to consider the report of a special committee appointed to investigate certain matters relating to Mr. Turner, the electrical engineer. In the report it was stated that Mr. Turner had taken out a patent for certain arrangements of steam piping which had been drawn out for the new electricity works, and had entered into an agreement with a Wednesbury firm of pipe makers to work the patent on royalty. Mr. Turner also communicated to this firm the names of firms submitting tenders for pipework. The Wednesbury firm then circularised these firms, pointing out that they were sole licensees for the patent. The chairman of the Electric Lighting Committee, Mr. Haworth, having learned of this, questioned Mr. Turner on the matter, and laid it before the Committee, which then decided not to open the tenders. On inquiry it was found that the amount of the royalties payable to Mr. Turner was £251 5s., and that in open market the successful tenderer would quote £1,300 less. Mr. Turner had also entered into an agreement with another firm. The Committee concluded that Mr. Turner had forfeited their confidence. After discussion it was resolved to accept the report, and that Mr. C. L. Turner be required to resign his position, with three months' salary in lieu of notice. It was also resolved, in view of a letter received from a Manchester solicitor, that if legal proceedings were brought against Councillor Haworth, the Council should undertake his defence.

**Sougtan.**—The Town Council has decided to apply for sanction to a loan of £28,500 for the carrying out of an electric lighting scheme.

**Spalding.**—The District Council, which owns the gas works, has decided to oppose an electric lighting scheme projected by a company.

**Tamworth.**—An application from Messrs. Handley and Shanks, electrical engineers, Birmingham, for the Town Council's consent to an application by them to the Board of Trade for a provisional order to supply electricity within the borough has been rejected.

**Totnes.**—The provisional order of the Totnes Electrical Supply Company, Limited, has been approved by the Board of Trade.

**Weymouth.**—The Town Council has adopted Prof. Kennedy's report on the question of lighting the borough with electricity, and has instructed him to prepare a scheme, &c., with a view to obtaining the sanction of the Local Government Board to a loan.

**Worcester.**—The City Council is about to adopt a "free" wiring system on a more reasonable basis than is usual with Corporations. The Council will put the contracts for the wiring in the hands of local tradesmen, and will charge the consumer 4 per cent. interest on the capital so expended. So long as the Council adheres to this system we have nothing to say against it; but we fear that the temptation to set up a staff of workmen and carry out the work itself may prove too strong for the Council. Application is to be made to the Local Government Board for sanction to a loan of £1,000 to defray the cost.

## ELECTRIC TRACTION NOTES.

**Blackpool.**—The Corporation electric trams at Blackpool have had a most successful year. Though there are only 16 cars, the receipts up to the end of March 31st were £22 590, compared with £18,196. The number of passengers were 3,421,730, compared with 2,881,027, and the distance covered 318,885 miles against 259,754. This year will prove far more successful, in view of the doubling of the lines and the extensions to the Gynn, which provide for a three-mile tram ride along the front. From April 1st to the 21st the receipts showed an increase of £400 over last year. Extensions are being carried out in various parts of the town.

**Bootle.**—At the Council meeting last week, speaking on the minutes of the Highways Committee, Alderman W. Thomas said he did not think they should proceed with the extension of the electric tramlines in Bootle until they had come to some agreement with the Liverpool Corporation with regard to the amount they had to pay them for the use of the lines in Stanley Road. Councillor Hall said that further communications had passed between the Tramway Committee of the Liverpool Corporation and the Highways Committee of the Bootle Corporation, but they had not resulted in a settlement. The matter had now been referred to the Board of Trade, with a request that they would decide the points at issue with as little delay as possible.

**Dublin.**—Dr. Henry Fitzgibbon has recovered £200 damages from the Dublin United Tramways Company for injuries caused to himself and to his horse and trap on November 27th through alleged negligence of the driver of an electric car. The jury found the plaintiff and the company were both guilty of negligence, but that the defendants could, by the exercise of ordinary care, have avoided the consequence of plaintiff's negligence.

**Dublin and Lucan.**—The other day the traffic on the Dublin and Lucan electric tramline came to a standstill for about three-quarters of an hour owing to some irregularity, it is supposed, in the power house. All the cars stopped running during the time mentioned.

**Holland.**—The Schuckert Company, of Nuremberg, has secured a contract to convert the tramways at The Hague into electrical lines.

**Huddersfield.**—In the House of Commons on Tuesday on the order for the consideration of the Huddersfield Corporation Tramways Bill, Sir John Woodhouse moved as an amendment that the Bill be re-committed to the former Committee. The Committee had reported that the Bill sought to make tramways within and also without the borough with the consent of the local authorities in whose districts they should be constructed and who supported the scheme, but that the Committee were of opinion that, having regard to the intended appointment by the Government of a Joint Committee to consider the question of municipal trading, they were not justified in sanctioning the proposed tramways extending to the suburbs. The power asked for by the Corporation in that respect having been struck out, his object was to obtain its re-insertion, which had the support of all the suburbs concerned, and which he maintained had nothing to do with the question of municipal trading. After some considerable discussion, the amendment was agreed to without a division.

**Leith.**—At a meeting of the Town Council last week the question of the tramways purchase was discussed, and it was agreed to take a *plébiscite* on the question of the purchase on the present basis of the negotiations.

**Light Railways.**—A Parliamentary paper has been published containing a report of the proceedings of the Board of Trade under the Light Railways Act (1896) during the year 1899, and of the proceedings of the Light Railway Commissioners during the period from December 1st, 1898, to December 31st, 1899. The Commissioners report, says the *Times*, that further experience has verified the apprehension, expressed in their previous report, that it would prove impossible for them to deal with the great and increasing number of applications within the proper time for so doing. In the year 1897 they held 48 local inquiries, in 1898 they held 54, and in 1899 they held 73; but arrears have nevertheless accumulated. They are, therefore, compelled to point out that unless some fresh arrangements are made there may be an increasing block of arrears detrimental to the working of the Act.

**Liverpool.**—The City Council has adopted a recommendation of the Tramways Committee to appoint Mr. P. M'Cullough, of Toronto, works superintendent and general assistant at £360 per annum (not £1,000, as was recently stated by a Canadian paper).

At the Council meeting last week there was a discussion as to whether the Corporation should pay the costs of Messrs. J. Goldberg and Son in the recent action, and the appeal, regarding the position of a tramway pole and fuse box. By 42 votes to 4 it was resolved not to pay the firm's costs. It was stated that the firm will probably appeal to the House of Lords.

A coal hawker has recovered £75 from the Liverpool Corporation as compensation for personal injuries sustained by collision with an electric tramcar in Dale Street on December 9th last.

**Llanelly.**—The Borough Council recently entered into an agreement with the British Insulated Wire Company by which the Corporation carries out a scheme at a cost of about £80,000. It was reported on Monday, however, that the company had failed to come to terms with the owners of the existing tramway at Llanelly. The Council thereupon decided to acquire the property (as they have power to do) for subsequent transference to the company, and it was unanimously resolved that the necessary application be made to the Board of Trade.

**Newport (Mon.).**—At the last meeting of the Lighting and Traffic Committee there was a discussion *re* the new electrical tramway which is to be constructed. The borough engineer asked for instructions upon several points in connection with the laying of the Corporation Road tramways to enable him to prepare the specification. He stated that it would be practically impossible to get Aberdeen or Cornish granite setts. In fact, the only setts available were German stone setts, and a composition block now being manufactured at Briton Ferry. It was resolved—

That the borough engineer be instructed to prepare a specification for the rails, with a groove of 1¼ inch (subject to Board of Trade approval), that they be purchased and supplied to the contractors as in previous cases, and that in preparing the specification for laying the tramway, he be instructed to provide for alternate tenders for the use of German setts, composite blocks, or other approved setts; that provision be made, with the sanction of the Works Committee, for lowering the road underneath the East Usk railway bridge, so as to give the necessary head room, and that the junctions for the siding into the proposed power station be included in the contract.

**Salford.**—The Mayor, Alderman Rudman, performed the ceremony of erecting the first post in Cross Lane in connection with the extensive electric tramway scheme that the Salford Corporation have in hand, with Messrs. Lacey, Clirehugh & Sillar as consultants. This portion of the system may be working within a very short time.

**Southport.**—The Tramways Committee recommend the Council to apply to the Board of Trade for power to borrow £40,000 for the purpose of relaying the lines recently purchased from the Birkdale and Southport Tramways Company, and for providing the necessary electrical equipment, cars, &c.

## TELEGRAPH AND TELEPHONE NOTES.

**Australian Cables.**—Reuter's Melbourne agent says that the Postmasters-General of New South Wales and Victoria have come to an agreement on the disputed points in the proposed agreement with the Eastern Extension Telegraph Company. The arrangement is made subject to the approval of the company, and the ratification by the Victorian and New South Wales Parliaments, which will not meet for two months. The tariff in the meantime will remain unaltered. The two Governments are to have the option of purchasing the cable. No other company is to be allowed to open offices in the Colonies before the Extension Company.

**Bradford Telephones.**—The telephonic breakdown was discussed at a meeting of the Corporation Finance Committee last week, and a proposal to establish a municipal exchange was made. The matter was referred to a sub-committee. Meanwhile the National Telephone Company have promised the Postal Committee of the Chamber of Commerce to put the system in thorough working order in a fortnight, which will be 13 weeks after the breakdown, generally attributed to the snowstorm of February 16th.

### Telegraphic Interruptions and Repairs:—

| Cables. | Down. | Repaired. |
|---|---|---|
| **West Indies:—** | | |
| Jamaica-Colon ... ... | ... June 30, 1899 ... | ... |
| Trinidad-Demerara (1891) | ... Oct. 22, 1899 ... | ... |
| Trinidad-Demerara (1871) | ... March 14, 1900 | May 6, 1900 |
| Mole St. Nicholas-Cape Haitien | ... March 6, 1900 ... | ... |
| San Domingo-Curaçoa ... ... | ... May 6, 1900 ... | ... |
| Cayenne-Pinheiro ... ... | ... Oct. 11, 1899 ... | ... |
| Cayenne-Paramaribo ... | ... Feb. 16, 1900 ... | ... |
| Ceará Maranham ... ... | ... Feb. 20, 1900 ... | ... |
| Pará-Maranham ... ... | ... March 1, 1900 ... | ... |
| Latakia-Cyprus ... ... | ... June 20, 1899 ... | ... |
| Manila-Iloilo ... ... | ... Apl. 9, 1900 ... | ... |
| Sitia-Rhodes... ... ... | ... Apl. 5, 1900 | May 5, 1900 |
| Tarifa-Tangier ... ... | ... Jan. 2, 1900 ... | ... |
| **Landlines.** | | |
| **West Indies:—** | | |
| Haitien landlines ... | ... Apl. 21, 1900 ... | ... |
| **South African:—** | | |
| Communication with Mafeking and beyond ... ... | ... Oct. 13, 1899 ... | ... |
| Communication beyond Aliwal North ... ... ... | ... Nov. 7, 1899 ... | ... |
| Communication beyond Ladysmith (Natal) ... ... | ... Nov. 7, 1899 ... | ... |
| Communication with offices beyond Kimberley and Bloemfontein ... ... ... | ... Oct. 18, 1899 ... | ... |
| Communication with Rhodesia, &c., is at present by post. Lourenço Marques to Beira, and thence by wire. | | |
| Communication with all offices of Colombia beyond Buenaventura... | Feb. 22, 1900 ... | ... |
| Communication "*vid* Hanekine" interrupted on Persian Territory | Feb. 24, 1900 ... | ... |
| Ecuador landlines ... ... ... | Mch. 13, 1897 ... | ... |
| Brasilian landlines, south of Macahe ... ... ... | ... Apl. 25, 1900 ... | ... |
| Moulmein-Bangkok ... ... | May 7, 1900 ... | ... |

when they knew that it was doubtful whether they could adequately to defray the cost.



**Northern Submarine Cable Project.**—The *Times* Copenhagen correspondent on 4th inst. says that he has every reason for believing that the projected cable from Denmark *vid* Scotland to Iceland will be laid by the Great Northern Telegraph Company with a subvention from Denmark and other foreign States. The Danish Aurora Borealis expedition, which has just returned from Iceland, highly favours the plan for meteorological purposes. The Great Northern Telegraph Company is said to be willing to make the sacrifice, though it does not expect that the project will pay.

**The N.T.C. and the State Royalty.**—The National Telephone Company is now making it quite clear to metropolitan subscribers that the whole of the sum paid annually as rental does not pass into the company's coffers. Hitherto the demand notes have requested the remittance of a lump sum as subscription, but these are at present being set out as rental, . . . . . , and 10 per cent. royalty to the Post Office, . . . . . , making a total of . . . . . For instance, one demand note asks for £12 3s. subscription, and £1 7s. royalty, or a total of £13 10s. In a second case £28 16s. is required as rental, and £3 4s. as royalty, making a total of £32. In former years these particular demand notes were simply made out as £13 10s. and £32 respectively.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Birkenhead.** — May 15th. The Corporation wants tenders for steam exhaust, feed water and drain pipework, &c., at the South End generating station. See "Official Notices" April 27th.

**Bradford.**—May 24th. The Corporation wants tenders for two steam engines and dynamos of 1,000-KW. each. See "Official Notices" May 4th.

**Bradford.**—May 24th. The Corporation wants tenders for the supply of enclosed electric motors of 4½, 7, and 10 H.P., for a period of 12 months, from July 1st. See "Official Notices" to-day.

**Bridgwater.**—June 7th. The Council wants tenders for the supply of boiler house plant, engine house plant, dynamos, pumps, switchboard, mains, lamp-posts, accumulators, meters, crane, &c., for electricity supply. See "Official Notices" this week.

**Burnley.**—May 14th. The Corporation wants tenders for laying about 2,000 yards of cable on the solid or other approved system. See "Official Notices" April 27th.

**Crewe.**—May 26th. The Council wants tenders for the supply and laying of about 25,000 yards of three-core cable, and 500 lampholders and reflectors for adapting the existing lamp-posts for electric lighting. See "Official Notices" this week.

**Crewe.**—June 11th. Tenders are wanted by the Corporation for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting (separate quotations for arc and incandescent lighting), the same. Tenders to Town Clerk.

**Devonport.**—May 25th. The Corporation wants tenders for electric light and traction feeders, distributors, boxes, &c. See "Official Notices" to-day.

**Dundee.**—May 22nd. The Town Council wants tenders for the supply of copper bonds for the city tramways. See "Official Notices" to-day.

**Edinburgh.**—May 21st. The City Council wants tenders for elevators and conveyors for coal and ashes at the McDonald Road electricity station. See "Official Notices" to-day.

**Glasgow.**—May 16th. The Corporation wants tenders for creosoted poles, oak arms, insulators, and iron work used in telephone construction. See "Official Notices" May 4th.

**Glasgow.**—May 19th. The Corporation wants tenders for the supply for one year of india-rubber covered and lead-covered branch cables; and carbons. See "Official Notices" May 4th.

**Glasgow.**—June 12th. The Corporation wants tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each, for the electricity department. See "Official Notices" to-day.

**Heywood.**—May 14th. The Corporation wants tenders for Lancashire boilers, economiser, pipe work, feed pumps, two steam dynamos, balancer, booster, travelling crane, batteries, switchboard connections, and station lighting mains, feeders and meters. See "Official Notices" April 27th.

**Italy.** — July 14th. The Municipal authorities of Maddalena (Sardegna), are inviting projects and tenders until July 14th, for the electric lighting of the public streets of the town. Particulars may be obtained from, and schemes and tenders are to be sent to, Il Municipio di Maddalena (Sardegna.)

**King's Lynn.** — May 17th. The Corporation invite tenders for steam dynamos, Lancashire boiler, economiser, pipes, switchboard, and cables for electric lighting works. See "Official Notices" April 27th.

**Leeds.**—May 28th. Tenders are wanted for two or three 630-KW. two-phase generators, and one or two sets of surface condensing plant, for the electricity works. See "Official Notices" May 4th.

**London.**—May 22nd. The Central Electric Supply Company, Limited, invites tenders for (1) two 1,200 I.H.P. Willans engines and three-phase H.T. generators (direct-coupled); (2) six three-phase H.T. motors direct-coupled to L.T. continuous current generator; (3) switchboards and connections. Specifications, &c., at the office of Prof. Kennedy. As to conditions and general particulars see our "Official Notices" April 20th.

**London.**—June 1st. The City Corporation Streets Committee invite proposals for the hire of an electrically-driven dust cart. See "Official Notices" April 20th.

**London.**—The Postmaster-General invites applications for specifications for galvanised iron strand stay wire for telegraph purposes. See "Official Notices" May 4th.

**London, W.**—The *Contract Journal* says that specifications, with plan and estimate, are invited for two 100-KW. dynamos, 200 volts, speed 450, suitable for Messrs. Willans & Robinson engines, with extended bedplate. Delivery to be made within three months from date of order. Also alterations to present switchboard. Farther details will be given by appointment with Chief Engineer, Whiteley's, Limited, 147, Queen's Road, Bayswater, London.

**Newcastle-on-Tyne.**—June 1st. The New Tramways Committee wants tenders for switchboards, underground feeders, and pumping apparatus. See "Official Notices" to-day.

**Paddington.**—May 14th.—The Vestry wants tenders for the execution of certain alterations to the existing electric lighting arrangements at the Baths. See "Official Notices" April 27th.

**Rathmines.**—May 21st. The Urban District Council invites tenders for the wiring of the out-houses at the rear of the Town Hall, the Fire Brigade Station, and the Public Library. Specifications, &c., from the Clerk of the Council, Town Hall.

**Rhyl.**—May 14th. The Council wants tenders for water-tube boilers and other steam plant; steam dynamos, pumps, &c.; switchboard; mains, lamp-posts, &c.; battery; meters; crane, &c., for electricity works. See "Official Notices" April 20th.

**Southampton.** — May 28th. The Corporation wants tenders for a water-tube boiler, with steam and other pipes, and sundry ironwork for the electricity works. See "Official Notices" this week.

**Tunbridge Wells.**—The Corporation wants tenders for a number of Shallenberger (Westinghouse) 1897 pattern ampere-hour meters. See "Official Notices" May 4th.

**Walthamstow.**—May 29th. The District Council wants tenders for arc lamps, posts, accessories, and glow lamps on existing gas standards. See "Official Notices" this week.

**Worksop.**—May 23rd. The District Council wants tenders for steam dynamos, balancers, boosters, and motors; Lancashire boilers; pipes, economiser, condenser, and feed pumps; switchboard; accumulators; cables, joint boxes, arc lamps and posts; overhead traveller for electricity works. See "Official Notices" May 4th.

### CLOSED.

**Brighton.**—The Town Council has accepted the tender of the Reason Manufacturing Company, Limited, for the supply of meters for a period of one year from June 1st, 1900, at £2 10s. per meter.

**Dundee.**—Various tenders in connection with the equipment of the electrical tramways extension were submitted to a meeting of the Tramway Committee on 1st inst. The tender of Lowdon Bros. & Co. for the traction switchboard was accepted. With regard to the mains, Sections A and B, which represent the cables that are to run along the tramway routes, which are to be laid by June, and the cables that are to be ready by September respectively, were secured by the British Insulated Wire Company, Limited, at a sum exceeding £8,000; and Section C, which represents the lighting for the ordinary town extensions, by the Callender Cable Construction Company, Limited, at a sum exceeding £2,000.

**Glasgow.**—The *Glasgow Mail* says that a large order for telephone instruments for the Corporation Exchange has been placed with the Ericsson-Bell Telephone Company, 50, Wellington Street, Glasgow. These instruments are of the type supplied to the Norwegian Government, and embody all the latest improvements. An order has also been placed with the General Electric Company, of London and Manchester, for wall instruments only. The companies agree to supply 1,550 instruments by the month of October, and thereafter large lots weekly.

**Glasgow.**—It is intended to get a glass floor for the switchboard gallery at the Pollokshaws Road Corporation electric supply station. The contract has been given to Messrs. Hayward Brothers & Eakstein, Limited, whose tender was £626 13s. 4d. Insulators have also been ordered for the station, the tender of the Port Dundas Pottery Company having been accepted.

**Rotherham.**—The Council has accepted the tender of Messrs. Thornton & Sons, Rotherham, to build an electric light generating station for the sum of £8,351.

reported on Monday, however, that the company had failed to come to terms with the owners of the existing tramway at Llanelly. The Corporation carries out a scheme at a cost of about £30,000.

| | | | | |
|---|---|---|---|---|
| Brasilian | Maldives, | South | of | |
| Macabe | ... | ... | ... | Apl. 25, 1900 ... ... |
| Moulmein-Bangkok | | ... | ... | May 7, 1900 ... ... |



**Keighley.**—At the Town Council meeting last week the tender was accepted of the Pendleton Ironworks Company, amounting to £1,112 1s. 6d., for constructional steel work in connection with electricity works.

**Maidstone.**—The following is a list of tenders received for Section J (pipework) in connection with the Corporation electric lighting scheme:—

| | |
|---|---|
| Alton & Co. (recommended for acceptance) .. .. .. | £1,432 0 0 |
| Williams & Sons, Limited .. .. .. .. .. | 1,680 0 0 |
| Spencer, John, Limited .. .. .. .. .. .. | 1,886 0 0 |
| Davey, Paxman & Co., .. .. .. .. .. .. | 1,986 0 0 |
| Alley & Macllellan .. .. .. .. .. .. .. | 2,000 0 0 |
| Babcock & Wilcox .. .. .. .. .. .. .. | 2,022 0 0 |
| Dann, Richard .. .. .. .. .. .. .. | 2,090 17 6 |
| Blackwell, Robert, Limited .. .. .. .. .. | 2,041 0 0 |

**Heywood.**—The Health Committee have accepted the tender of Messrs. Meldrum Bros., for the machinery required for the proposed refuse destructor. The estimated cost of the destructor—buildings and machinery—is £4,500.

**Warrington.**—The Klein Engineering Company has lately received an order from the Corporation to erect at their new electricity station a Klein central barometric jet condensing plant for engines of 1,250 H.P.

## FORTHCOMING EVENTS.

**Friday, May 11th.**—At 5 p.m. Physical Society. Agenda:—(1) Discussion of Prof. Lodge's paper "On the Controversy concerning Volta's Contact Force." (2) "The Heat of Formation of Alloys," by Mr. J. B. Tayler. (3) "On the want of Uniformity in the Action of Copper-Zinc Alloys on Nitric Acid," by Dr. Gladstone, F.R.S. (4) "An Electro-magnetic Experiment, and Experiments illustrating the Aberration called Coma," by Prof. S. P. Thompson, F.R.S.

**Monday, May 14th.**—At 8 p.m. Society of Arts. (Cantor Lecture.) "The Incandescent Gas Mantle and its Use," by Prof. Vivian B. Lewes. (Lecture II.)

**Tuesday, May 15th.**—At 7.30 p.m. Students' Meeting of the Institution of Electrical Engineers at the Finsbury Technical College, Leonard Street, Finsbury, E.C. Mr. R. P. Howgrave-Graham, Student, will read a paper on "Hertz Waves and Wireless Telegraphy." Prof. S. P. Thompson, F.R.S., will preside.

**Thursday, May 17th.**—At 3 p.m. Royal Institution. Prof. Dewar on "A Century of Chemistry in the Royal Institution."

At 8 p.m.—Institution of Electrical Engineers will meet by kind permission at the Institution of Mechanical Engineers, Storey's Gate, S.W. "Alternating Current Induction Motors," by A. C. Eborall, Associate.

**Friday, May 18th.**—At 8 p.m. The Institution of Junior Engineers. Meeting at Westminster Palace Hotel. Paper on "A Short Review of the Motor Car Industry," by Basil H. Joy and Charles H. Rush.

At 9 p.m.—Royal Institution. "The Structure of Metals," by Prof. J. A. Ewing.

**Saturday, May 19th.**—At 7.30 p.m. Manchester Society of Junior Electrical Engineers. Meeting at Engineering Laboratories, Whitworth Street, Manchester. Paper by T. E. Herbert, on "The Application of Accumulators to Telegraphy and Telephony."

Institution of Electrical Engineers.—Students' Visit to the India-Rubber, Gutta-Percha, and Telegraph Works, Silvertown. Students wishing to take part must send their names and addresses to Mr. J. T. Haynes, 43, Brownswood Road, Finsbury Park, N., by Tuesday, May 15th.

## NOTES.

**The Laying of Mains.**—An inquiry was recently held by Mr. A. P. Trotter in respect of the disapproval by the St. Marylebone Vestry of certain works proposed to be carried out by the Metropolitan Electric Supply Company, under the West London Order, 1889. The Board of Trade has now allowed the company's appeal, subject to the condition that the trench for the mains and pipes shall not exceed 2 feet in width unless obstacles be found which may limit the depth of the trench, and in such case the trench may be wider, but in no case shall the sectional area exceed 2 square feet. As a result of the appeal the Vestry is fixing this condition in similar instances where the works proposed are of an unusual character.

**American Society of Mechanical Engineers.**—The following are among the subjects of papers to be read at the meeting of this Society, which is to be held next week—from May 15th to 18th—at Cincinnati, Ohio:—

"On the Value of a Horse-Power," by Geo. I. Rockwood.
"Hot Water Heating from a Central Station," by H. T. Yaryan.
"Efficiency of Systems of Electric Transmission in Factories and Mills," by W. S. Aldrich.
"Multiple Cylinder Engines," by Robt. H. Thurston.
"The Gas Engine Hot-Tube as an Ignition Timing Device," by Wm. T. Magruder.
"Water Softening Plant of the Lorain Steel Company," by N. O. Goldsmith.
"Education of Machinists, Foremen and Mechanical Engineers," by M. P. Higgins.
"The Automobile Wagon for Heavy Duty," by Arthur Herschmann.
"Cylinder Proportions for Compound and Triple Expansion Engines," by B. C. Ball.
Topical Discussions.
"What does it Cost to Run Trains at High Speed?"

**The British Association Meeting at Bradford.**—This year's meeting of the B.A. is to be held at Bradford, commencing Wednesday, September 5th. The president-elect is Prof. Sir William Turner. Section A, Mathematical and Physical Science, will be presided over by Prof. Joseph Larmor, D.Sc., F.R.S., the Department of Astronomy in this section having Dr. Common, F.R.S., for its chairman. Section B, Chemistry, president, Prof. W. H. Perkin, F.R.S. Section G, Mechanical Science, president, Sir A. R. Binnie. An evening discourse on "Animal Electricity" will be delivered on September 7th by Prof. Gotch, F.R.S. Papers have to be submitted to the general secretaries, British Association, at Burlington House, W., on or before August 1st. Electrical engineers who are in a position to contribute papers of interest in Sections A or G should take a note of this date. Paris conferences notwithstanding, it is to be hoped that the British Association Bradford meeting of 1900 will be of a little more interest to electrical engineers than have been some recent B.A. gatherings. There is now plenty of time for electrical scientists to prepare papers. The local honorary secretaries are Messrs. Ramsden, Bacchus, John E. Fawcett, and Frederick Stevens, and their address is 5, Forster Square, Bradford, Yorks.

**The Belleville Boiler.**—The *Pall Mall Gazette* of Wednesday had the following important note:—

We have reason to believe that an important change is impending in the policy of the Admiralty on the boilering of the ships of the Royal Navy. We have argued for a long time past, on the evidence that was collected in the columns of the *Pall Mall Gazette* early last year, that the wholesale adoption of Belleville boilers for our battleships and cruisers was a grave error of judgment. Experience has proved that this contention was at least well founded, and we believe that the Lords of the Admiralty have at last recognised this. Their conversion has been assisted not a little by the record of the *Powerful*, which crept home from the Cape at less than half her designed speed, and will now have to be practically eviscerated before she can be recommissioned for service. If, as we are given to understand, the Admiralty are now convinced that it would be dangerous to rely on this type of boiler in time of war for other than torpedo craft, the naval service will welcome the fact with immense relief. But the change of policy involved will necessarily cause the Lords of the Admiralty to revise the *personnel* of the consultative engineering branch. Several important changes are, we believe, in contemplation, and with them it may be expected that a reform vitally affecting the efficiency of the Fleet will be commenced immediately. As a preliminary, it would be desirable that a committee of experts should at once be appointed to examine the whole boiler question.

**More Smoke.**—At a recent meeting of the St. Saviour's Board of Guardians, it was asked what stage had been reached in the action against the City Company for permitting smoke to escape from their shafts. This thing is going too far. What are chimneys for, if not to permit smoke to escape?

**The Electrical Standardising, Testing and Training Institution.**—Prof. Carus-Wilson will commence a special course of lectures upon "The Construction and Use of Motors" to the senior students of this Institution on Monday, May 28th.

switchboard, and cables for electric lighting works. See "Official Notices" April 27th.

Messrs. Thornton & Sons, Rotherham, to build an electric light generating station for the sum of £8,351.



**The Factory and Workshops Bill.**—The above Bill, as introduced by the Home Secretary, greatly enlarges the powers of that official in respect of so-called dangerous trades and overtime exceptions, and it is submitted by the Manufacturers' Section of the London Chamber of Commerce that these discretionary powers should be matter of statutory enactment rather than dependent on the personal idiosyncrasy of the Home Secretary for the time being. Failing to carry this view, they suggest certain amendments to cope with the objections they have to the provisions of the Bill. One of the objectionable provisions is that which gives the London County Council the veto on the provisions against fire protection in London workshops. Factories erected before 1892, and workshops erected before 1896, must be approved by the County Council, but there is an appeal to arbitration, which has been a protection to manufacturers against the arbitrary action of the County Council. The new Bill places all workshops and factories absolutely at the mercy of the County Council, and those who know that body and its officialism will agree that it is not fit to possess such absolute power as to decide if a workshop can be continued in use. Absolute power is not a fit attribute for any man or any society, and it is satisfactory that anything tending to grant such power should be carefully watched and combatted.

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**Parliament and Electrical Schemes.**—The present attitude of Parliament towards electrical schemes is notable and, at the same time, satisfactory. There has been, in fact, a remarkable change in the legislature, even in the last few years, on electrical questions. One need go back no further than a few sessions to discover a distinct antipathy to electrical measures of any description. Probably, the activity of municipalities on electrical questions did much to enlighten or influence members of Parliament towards a kinder appreciation of new schemes, and the conspicuous success of both lighting and tramway systems has completed the conversion. When one considers the various projects that have been made possible by Parliamentary sanction, the record of the past three years is by no means a bad one. Although London is considered in electrical matters to be much behind many of the provincial towns, it is in some respects likely to be ahead of the world; we refer to the electrical underground railways that are under construction, and others that are projected. By no other means can the suburban residents of London be brought to their places of business with celerity. With probably two exceptions the railway lines that enter London terminate at considerable distances from business centres, and the necessity of a quick and efficient form of transit between various points in the metropolis is a great one. It is important, therefore, not only to the electrical industry, but also to the public that such proposals as the extension of the Baker Street and Waterloo line, which is engaging the attention of a Parliamentary Committee, should receive the approbation of Parliament. The construction of the line from Baker Street to Waterloo is well under way, and serving as a feeder to the Metropolitan and the South-Western Railway, it obviously meets with the approbation and support of such companies, but it is doubtful whether the opposition of the Metropolitan Company against the extension to Paddington will not be fairly strong, and likely to carry weight with a Committee. Apart, however, from the question of competition which the electrical line would meet in the event of it obtaining powers to extend to Paddington, it would not be surprising if sanction were obtained, judging from the present temper of Parliamentary representations.

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**Appointments Vacant.**—The Johnson-Lundell Electric Traction Company want an engineer and manager; also a secretary. For particulars as to qualifications, &c., see "Official Notices" this week.

An electrical clerk of works is required for the Accrington Electricity Works. An assistant electrical engineer is wanted by the Hastings Corporation at £120 per annum. An electrical engineer is wanted by the Salford Corporation at £400 per annum. See "Official Notices" this week.

An electrical engineer is wanted by the Leith Town Council at £250, to commence duties on 21st inst.

**The Smelting Corporation's Works at Ellesmere Port.**—The Crocker-Wheeler Company, of New York, has been awarded an order for a 400-KW. direct connected generator, and four motors aggregating 240 H.P., for the Smelting Corporation, Ellesmere Port, Cheshire, England. The value of the order, according to the New York *Electrical Review*, is $13,500. The Smelting Corporation's electric equipment is said to be entirely of American manufacture, fully $100,000 having been expended in this direction. The Crocker-Wheeler Company received the contract for three 400-KW. direct connected generators, and 20 motors, varying from 12 H.P. to 100 H.P., valued in all at about $25,000. The Edward P. Allis Company, of Milwaukee, supplied two 500-H.P. engines. The Crane Company, of Chicago, furnished all the requisite piping, valves, &c. The Connersville Blower Company, of Connersville, Ind., manufactured the pumps, while Wheeler condensers, also Hoopes feed-water heaters and separators, are utilised throughout the English plant.

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**Power or Energy?**—We have become somewhat inured to the confusion of these terms in a moderate degree, but never have we seen such an extraordinary misuse of them as in an article entitled "The Power in a Pound of Coal," appearing in the current issue of *Cassier's Magazine*, over the signature of Mr. E. D. Meier. The title itself is sufficiently absurd; what would the author say to "the length in a pound of butter," or "the time in a yard of pump water?" Yet these are every bit as reasonable as the heading of his article. Let him speak for himself:—"Let us take a pound of what we will call average coal, containing, say, 10,000 heat units. This would be somewhat smaller in size than a man's fist. A pound of this coal, if expended in mechanical work, would give us 236 H.P." For that matter, it would give 236,000 H.P., or 0·00236 H.P.—it all depends. "In some countries men who have been specially trained as porters to carry heavy loads on their backs, will, as a full day's work, carry a total of from 350 to 600 lbs. a distance of 1 mile. And yet each has expended but one-third of the power stored up in this pound of coal." The author evidently believes that to carry a pound for a mile is the same as to lift it through a height of a mile—this apart from the misuse of the word "power." So again—"In sawing wood, a man may work at the rate of about 60 strokes a minute, and consider himself a 'top-sawyer,' and his saw blade may have progressed 5 feet a minute; but a circular saw, driven by machinery, may be put through 20 times that distance, and saw 70 times as much wood. And yet this one little pound of coal contains power enough for 180 such saws." One would not trouble to notice such misconceived views, were it not that it is found in the pages of a highly-esteemed engineering magazine; the technical press at least should be above reproach in the discussion of matters appertaining to power and energy.

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**Building Trades' Gift.**—We are informed by Mr. E. O. Sachs that a matinée performance is being arranged at the Theatre Royal, Drury Lane, on Tuesday afternoon next (May 15th) on behalf of the homes presented by the building trades, with a view of forming a special fund for the maintenance and repair of the homes. H.M. the Queen has graciously accepted the patronage of the matinée, and H.R.H. the Princess of Wales has kindly intimated her intention to be present. H.R.H. the Princess Christian and T.R.H. the Duke and Duchess of Connaught have also given their patronage, while a number of noble and distinguished ladies are on the Organising Committee, and every actor and actress of note in London is taking part in the performance.

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**Personal.**—The St. Helens Town Council has increased the salary of the borough electrical engineer, Mr. J. S. Highfield, from £300 to £400, and of his assistant, Mr. E. M. Hollingsworth, from £110 to £150 per annum.

Mr. W. H. Illingworth, of Halifax, has been appointed mains superintendent, at a salary of £150 per annum, by the Cardiff Town Council.

Mr. Cook, the manager of the Big Wheel for some time back, shortly leaves Blackpool to become the secretary and manager of the Carlisle Corporation's electric tramways.

are of an unusual character.

Monday, May 28th.



**Obituary.**—We regret to learn of the death of Mr. W. C. Smythe, electrician to the Telegraph Department at Wellington, New Zealand.

The death is announced of Mr. William Erskine Bartlett, managing director of the North British Rubber Company, at the age of 70 years.

**Royal Institution.**—At a meeting of the Institution on Monday the Duke of Northumberland, K.G., president, announced that he had nominated the following vice-presidents for the ensuing year:—Sir F. Bramwell, Right Hon. Lord Lister, Dr. Ludwig Mond, Sir A. Noble, Mr. A. Siemens, the Hon. Sir J. Stirling, Sir J. Crichton Browne, and Sir W. Crookes.

**Errata.**—In Mr. Bawtree's paper appearing in this issue the following errors appear:—Page 806, first column, line 12, for *touch* read *tough*; line 24, for *softer* read *harder*; second column, line 19, read "that *at* a current density," &c.

## NEW COMPANIES REGISTERED.

**Cowper Inventions Development Company, Limited** (65,755).—This company was registered on April 24th, when a capital of £50,000 in £1 shares, to adopt an agreement with S. Cowper-Coles, and to carry on the business of iron and brass founders, engineers, machinists, tool makers, smiths, chemical manufacturers, electricians, electrical engineers, &c. The first subscribers (each with one share) are:—H. W. Brown, 59, Mackenzie Road, Beckenham, journalist; E. T. Church, 34, Geneva Road, Brixton, S.W., clerk; J. W. Honess, 35, Florence Road, Wimbledon, S.W., secretary; E. Wyatt, Bangor House, Lausanne Road, Hornsey, N., gentleman; A. W. Lawson, 43, Forest Drive West, Leytonstone, secretary; W. J. O'Brien, 6, South Hill Park, Hampstead, N.W., clerk; and W. Farrier, 9, Lime Street, Walthamstow, clerk. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, £250; remuneration, £50 each per annum and a share in the profits.

**Marconi International Marine Communication Company, Limited** (65,758).—This company was registered on April 25th, with a capital of £350,000 in £1 shares, to acquire certain licenses and powers from Marconi's Wireless Telegraph Company, Limited, to construct and deal with telegraphic apparatus, and to carry on the business of electrical and general engineers, &c. The first subscribers (each with one share) are:—S. F. Page, 35, St. George's Square, S.W., managing director; H. S. Saunders, 15, Great St. Helens, E.C., merchant; H. H. Allen, 28, Mark Lane, E.C., secretary; P. H. Stewart, 10, Mavgrove Road, Bromesbury, N.W., civil engineer; F. S Tomkins, 59 Klea Avenue, Clapham, S.W., secretary; J. McGowan, Claremont, Palmer's Green, N., clerk; and W. H. Benham, 19, Valmar Road, S.E., clerk. The number of directors is not to be less than five nor more than 20; the first are M. Balser, M. le Col. Thys, M. M. Travailleur, M. de Volder, J. F. G. Bannatyne, G. Marconi, A. Ochs, Major S. F. Page, H. S. Saunders, and Sir C. Euan-Smith; Marconi's Wireless Telegraph Company, Limited, may appoint three directors; qualification, £100; remuneration, £3 000 or £4 000 per annum (according to number) and a share in the profits, divisible.

**South Shields Electrical Engineering Company, Limited** (65,786).—This company was registered on April 28th, with a capital of £2,000 in £1 shares, to carry on the business of electrical and general engineers, electro-platers, electricians, suppliers of electricity for the purposes of light, heat, motive power, and otherwise, manufacturers of electrical apparatus, &c., and to adopt an agreement with Thomas W. Ogilvy. The first subscribers (each with one share) are:—F. W. Ogilvy, 10, Rosebery Avenue, South Shields, electrical engineer; C. R. Toomer, Ravensworth, Westre, South Shields, engineer; J. T. Atkin, Salisbury House, South Shields, builder; A. Purvis, Helena Terrace, South Shields, master mariner; A. P. Stainton, 37, King Street, South Shields, solicitor; C. Macdonald, 69, Brodrick Street, South Shields, surveyor; F. McKenna, 4, St. Nicholas Buildings, Newcastle, engineer. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, £50.

**National Construction Company, Limited** (65,790).—This company was registered on April 28th, with a capital of £10,000 in £1 shares, to construct conduits, cables, wires, lines, accumulators and works for electrical and other purposes, and to carry on the business of electrical engineers, suppliers of electricity, &c. The first subscribers (each with one share) are:—A. Benwell, 10, Machell Road, Nunhead, S.E., clerk; H. G Carvall, 52, Mortimer Road, Kingland, N., clerk; A. Pitt, 34, Clement's Lane, E.C., clerk; N. G. Newington, 125, Croxted Road, West Dulwich, clerk; C. T. Price, 5, Prince Arthur Road, Hampstead, N.W., solicitor; J. H. Bodell, 49, Fawcett Road, S.E., clerk; and C. W. Barrett, 8, Tennyson Street, S.W., clerk. The number of directors is not to be less than three nor more than seven. The first are H. R. Gamble, E. S. Perrot, G. J. Jackson, and F. W. Abbot; qualification £1,000; remuneration as fixed by the company. Registered office, 23, College Hill, E.C.

**St. Stephen's Electrical Syndicate, Limited** (65,804).—This company was registered on April 30th, with a capital of £8,000 in £1 shares, to acquire and carry on the business of an electrical, hydraulic, and mechanical engineer, carried on by J. E. Taylor at St. Stephen's Works, St. Stephen's Avenue, Shepherd's Bush. The first subscribers (each with one share) are:—E. Buchholtz, 223, The Grove, Hammersmith, electrical engineer; J. E. Taylor, 14, Percy Road, Shepherd's Bush, electrical engineer; E. S. Templeton, 10, Ravenscourt Gardens, W., civil engineer; H. G. Well, 35, Boscombe Road, W., engineer; G. Richberg, 223, The Grove, Hammersmith, engineer; W. J. Chapman, 34, Boscombe Road, Shepherd's Bush, engineer; and F. Smith, 16, Percy Road, Shepherd's Bush, instrument case maker. Registered without articles of association.

**Rubber Chemical Company, Limited** (65,816).—This company was registered on May 1st, with a capital of £30,000 in £1 shares, to carry on the business of producers, workers, manufacturers and manipulators of so-called "reclaimed india-rubber," chemical manufacturers, manufacturers of india-rubber, gutta-percha, leather and other goods, electricians, &c. The first subscribers (each with one share) are:—T. Barclay, Uplands, Blackville, near Bromsgrove, manufacturing chemist; A. Southall, Carrick House, Richmond Hill, Birmingham, manufacturing chemist; J. Barclay, The Lenthurst, near Bromsgrove, manufacturing chemist; C. E. Naish, 100, Willows Road, Balsall Heath, Birmingham, manager; T. Ground, Malvernhurst, School Road, Moseley, Birmingham, manager; O. H. Hunt, 58, Pershore Road, Edgbaston, manager; and W. T. Heal, 5, Charlesville Road, Handsworth, manager. The number of directors is not to be less than three nor more than five; the first are Thomas Barclay, John Barclay and Alfred Southall; remuneration, £52 10s. each per annum.

**North Wales and District Light Railway and Electric Power Syndicate, Limited** (65,824).—This company was registered on May 2nd, with a capital of £1,200 in £100 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for light, heat, motive power and otherwise, telegraph, telephone and railway proprietors, &c. The first subscribers (each with one share) are:—J. Wolstenholme, 6, St. Mary's Gate, Manchester, agent; J. Royle, Hesketh, 22, Brazenose Street, Manchester, chartered accountant; E. Hague, 12, Lloyd Street, Manchester, cloth merchant; F. F. Bennett, 13, Victoria Buildings, Manchester, engineer; W. T. Pressland, 11, Delahaye Street, Westminster, engineer; W. H. Davies, Pwllheli, solicitor; and B. D. Beever, 91, Portland Street, Manchester, salesman. The number of directors is not to be less than three: the first are to be appointed by the subscribers; qualification, £100; remuneration as fixed by the company.

**Automobile Manufacturing Company, Limited** (65,793).—This company was registered on April 30th, with a capital of £100 in £1 shares, to acquire the business carried on by W. C. Bersey, at 4, Hythe Road, Willesden, N.W., and the business of the Southern Motor Car Company, carried on at 59, Brixton Road, S.W., by Townsend and Bizzey, and to carry on the business of electrical and general engineers, motor carriage manufacturers, &c. The first subscribers (each with one share) are:—W. C. Bersey, 34, North Street, Manchester Square, W., engineer; E. Townsend, Monument Buildings, E.C., merchant; H. S. Wyndham, Hill Top, Thornton Heath, Surrey, gentleman; A. E. Bizzey, Monument Buildings, E.C., merchant; S. Lambert, 59A, Bishopsgate Street, E.C., chartered accountant; H. Webster, The Cottage, Upper Coombe Street, Croydon, cashier; and A. A. Brown, 65, Skelton Road, Forest Gate, Essex, clerk. Registered without articles of association.

**Automobile Company of Great Britain and Ireland, Limited** (65,832).—This company was registered on May 3rd, with a capital of £100 in £1 shares, to carry on the business of motor and motor cycle makers, and manufacturers of all kinds of vehicles, whether propelled or drawn by steam, oil, electricity, or other mechanical or animal power. The first subscribers (each with one share) are:—A. T. Prudey, 28, Castle Street, N., clerk; L. Kennedy, 2, Richmond Terrace, S.W., clerk; J. Likeman, 50, Effingham Road, N., salesman; A. W. Hoale, 116, Craven Park Road, Harlesden, N.W., accountant; W. Norris, 22, Norfolk Road, Thornton Heath, clerk; H. G. Thomas, 36, Greenwood Road, Hackney, manufacturer; and T. T. Bradbury, 40, Holborn Viaduct, E.C., secretary. Registered without articles of association.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Barcelona Tramways, Limited** (6,544).—This company's annual return was filed on April 8th, when the entire capital of £300,000 in 20,000 ordinary and 10,000 preference shares of £10 each had been taken up and paid in full.

**Metropolitan Electric Supply Company, Limited** (25,395).—This company's annual return was filed on April 19th, when 85,000 shares were taken up out of a nominal capital of £1,000,000 in 100,000 shares of £10 each, £10 has been called up on each of the 82,968 shares, resulting in the receipt of £829,680; £20,320 is considered as paid on 2,032 shares.

Council at £250, to commence duties on 21st inst.

manager of the Carlisle Corporation's electric tramways.



**City of London Electric Lighting Company, Limited** (34,406).—This company's annual return was filed on April 19th, when 40,000 preference and 60,000 ordinary shares were taken up out of a nominal capital of £1,200,000 in 40,000 preference and 80,000 ordinary shares of £10 each; £10 per share has been called up, resulting in the receipt of £1,000,000.

**Electric Sign and General Advertising Company, Limited** (45,610).—This company's annual return was filed on February 23rd, when 2,000 shares were taken up out of a nominal capital of £5,000 in £1 shares; £1 per share has been called upon 1,000 shares, resulting in the receipt of £1,000; £1,000 is considered as paid on the remainder.

## SUPPLY STATION ACCOUNTS.

### Bath Corporation Electricity Accounts.

The accounts of the electricity undertaking of the Bath Corporation for 1899 show a marked improvement as compared with 1898, during which the works were being reconstructed, and the supply was being carried on under great difficulties, but the general condition of the business can hardly yet be regarded as satisfactory. The increase in maximum supply is nearly three times what it was in 1898, yet the increase in output is considerably less, thus indicating that the new consumers are drawn from a class which cannot materially assist in improving the load factor, or tend towards reduced costs. The general position is shown by the

GENERAL STATEMENT.

| | 1898. | 1899. | Increase. |
|---|---|---|---|
| Total capital expenditure ... | £51,561 | £63,006 | £11,445 |
| Number of units sold ... | 356,700 | 388,208 | 31,508 |
| Total maximum supply demanded ... ... ... | 330 KW. | 382 KW. | 52 KW. |
| Gross revenue ... ... | £7,113 | £7,296 | £183 |
| Gross profit ... ... ... | £1,478 | £2,173 | £695 |
| Average price per unit sold... | 4·48d. | 4·33d. | −·15d. |

The output was taken in large part by the public lamps, being distributed as follows:—

| | Quantity generated. | Sold public lamps. | Sold private consumers. | Number of public lamps. |
|---|---|---|---|---|
| 1897 | 514,224 | 138,200 | 176,520 | 88 arcs. |
| 1898 | 537,052 | 169,385 | 187,315 | 87 arcs and 21 incandescents of 16 C.P. |
| 1899 | 569,986 | 179,261 | 208,947 | 88 arcs and 13 incandescents of 50 C.P. |

Each item in the revenue account shows a fall per unit. Whereas "supply, &c., of lamps" in 1897 yielded £395, in 1899 this source of revenue only brought in £33, while "sundry fees" have dropped in something like a similar ratio. The revenue per unit for current is being steadily reduced, and ought to encourage a larger demand.

REVENUE STATEMENT.

| | 1898. Gross. | 1898. Per unit. | 1899. Gross. | 1899. Per unit. | Increase. |
|---|---|---|---|---|---|
| Sale of current .. .. | £6,665 | 4·48d. | £6,996 | 4·33d. | −·15d. |
| Meter rents .. .. .. | 237 | ·16d. | 259 | ·16d. | ... |
| Supply and repairs of lamps, &c. .. .. .. | 123 | ·09d. | 33 | ·02d. | −·07d. |
| Sundry fees, &c. .. .. | 88 | ·06d. | 8 | ... | −·06d. |
| Gross revenue ... | £7,113 | 4·79d. | £7,296 | 4·51d. | −·28d. |

In the "costs" some of the anomalies of the previous year are reproduced. Thus repairs, which stood at £985 in 1897, are now down to £394, and Mr. Metzger has, by some method other engineers would, we are sure, like to imitate, again managed to reduce that stubborn item of rates from £127 in 1897, to £84 in 1898, and now to £77. Further "management expenses," which rose from £946 in 1897 to £1,217 in 1898, have been brought down to £1,084 in 1899. The improvement in works' cost in 1899 is considerably more than in 1898, and is bettered (instead of being lessened as in 1898) by the reductions in other items, showing less than 3½d. as total costs, as compared with nearly a penny more than this two years ago.

COSTS OF PRODUCTION.

| | 1898. Gross. | 1898. Per unit. | 1899. Gross. | 1899. Per unit. | Increase. |
|---|---|---|---|---|---|
| Coal .. .. .. .. | £2,107 | 1·41d. | £1,701 | 1·05d. | −·36d. |
| Oil, waste, water and engine room stores. | 432 | ·29d. | 554 | ·34d. | +·05d. |
| Salaries and wages incurred in generation and distribution. | 892 | ·60d. | 1,032 | ·64d. | +·04d. |
| Repairs and maintenance of buildings, engines, boilers, dynamos, &c. | 614 | ·42d. | 394 | ·25d. | −·17d. |
| Works' cost ... | £4,045 | 2·72d. | £3,681 | 2·28d. | −·44d. |
| Rent, rates, and taxes .. | 137 | ·09d. | 131 | ·08d. | −·01d. |
| Management expenses, salaries of managing engineer, secretary, clerks, &c. | 1,217 | ·82d. | 1,084 | ·67d. | −·15d. |
| General establishment charges, stationery and printing, law charges and insurance. | 173 | ·12d. | 208 | ·13d. | +·01d. |
| Other expenses .. .. | 63 | ·04d. | 19 | ·01d. | −·03d. |
| Total costs ... | £5,635 | 3·79d. | £5,123 | 3·17d. | −·62d. |

It will be remembered that last year the surplus was shown as £125, this being really only a portion of the surplus of 1897 carried forward and included in the 1898 accounts. The increase in sinking fund and interest from £2,225 in 1898 to £3,978 last year more than absorbs the surplus balance carried forward and gross profit of last year, and results in a net deficiency of £1,805, which is carried forward, thus burdening the future of the undertaking rather heavily.

PROFIT STATEMENT.

| | 1898. | 1899. |
|---|---|---|
| Interest on loans .. .. .. .. .. | £1,478 | £1 732 |
| Sinking fund for repayments .. .. .. | (747) | 2,246 |
| Net profit carried forward .. .. .. | (125) | −1 805 |
| Gross profit ... ... ... | £1,478 | £2,173 |

### Huddersfield Corporation Electricity Accounts.

When dealing with the accounts of the electricity undertaking of the Huddersfield Corporation during the years 1897 and 1898, we were able to refer to the steady and sound progress being made. During the last year this satisfactory state of affairs was maintained, and Mr. Mountain must be congratulated upon the figures which we have to deal with. The business has evidently been developed further as regards output than in the way of extensions, the increase in capital expenditure during 1899 being a little more than half that during 1898, but on the other hand, the increase in output of the later year is more than double the increase during the former.

GENERAL STATEMENT.

| | 1898. | 1899. | Increase. |
|---|---|---|---|
| Total capital expenditure ... | £93,494 | £106,684 | £13,190 |
| Number of units sold ... ... | 593,377 | 951,033 | 357,656 |
| Number of lamps connected ... | 54,154 | 70,178 | 16 024 |
| Gross revenue ... ... ... | £11 866 | £15,643 | £3,777 |
| Gross profit ... ... ... | £6 937 | £9,041 | £2,104 |
| Average price per unit sold ... | 4·51d. | 3·53d. | −0·98d. |

Probably the most marked change in the foregoing statement is the drop of nearly 1d. in the average price per unit sold, the figure being now as low as just over 3½d. This no doubt accounts for the jump from less than 600,000 to over 950,000 units output; this being the result of a reduction in price over the second half of the year from 6d. per unit with discounts from 2 to 25 per cent., to 4½d. per unit with discounts from 1 to 15 per cent., according to consumption.

Under the head of "Sundry receipts" appears an item of £700. This is the "amount ordered to be paid by the defendants in full settlement of all claims and costs in Corporation *v.* Siemens Brothers and Co, Limited." While under "Other Expenses" in the "Costs" table is shown a sum of £336 being due to "Legal Expenses: Corporation *v.* Siemens Brothers, Limited, including defendants' costs."

REVENUE STATEMENT.

| | 1898. Gross. | 1898. Per unit. | 1899. Gross. | 1899. Per unit. | Increase |
|---|---|---|---|---|---|
| Sale of current .. | £11,153 | 4·51d. | £14,009 | 3·33d. | −·98d. |
| Meter rents .. .. | 630 | ·25d. | 827 | ·21d. | −·04d. |
| Supply, &c., of lamps | 83 | ·04d. | 107 | ·03d. | −·01d. |
| Sundry .. .. ... | ... | ... | 700 | ·18d. | +·18d. |
| Gross revenue | £11,866 | 4·80d. | £15,643 | 3·95d. | −·85d. |

The costs are interesting as showing clearly the influence increased output has upon the various items. Thus:—

| | 1897. | 1898. | 1899. |
|---|---|---|---|
| Output ... ... ... ... | 438,848 | 593,377 | 951,033 |
| Coal ... ... ... ... | ·49d. | ·47d. | ·46d. |
| Oil, waste, &c. ... ... ... | ·06d. | ·07d. | ·08d. |
| Wages ... ... ... ... | ·54d. | ·53d. | ·30d. |
| Repairs ... ... ... ... | ·43d. | ·34d. | ·23d. |
| Rent, rates, &c. ... ... ... | ·17d. | ·13d. | ·21d. |

With the exception of "Oil, waste," and "Rent, rates, and taxes," each item has fallen (if we exclude the particular legal costs referred to above). Works' costs and total costs have each fallen by ½d., and the total costs are now down to the excellent figure of 1¾d. The satisfactory character of the figures is best evidenced by the readiness with which the usually awkward item of "Repairs," has come down to less than ¼d.

COST OF PRODUCTION.

| | 1898. Gross. | 1898. Per unit. | 1899. Gross. | 1899. Per unit. | Increase. |
|---|---|---|---|---|---|
| Coal .. .. .. .. | £1,170 | ·47d. | £1,814 | ·46d. | − 01d. |
| Oil, waste, water, and engine room stores | 161 | ·07d. | 309 | ·08d. | + 01d. |
| Salaries and wages incurred in generation and distribution | 1,309 | ·53d. | 1,206 | ·30d. | − 23d. |
| Repairs and maintenance of buildings, engines, boilers, dynamos, &c. | 840 | ·34d. | 919 | ·23d. | − 11d. |
| **Works' costs ... ...** | £3,480 | 1·41d. | £4,248 | 1·07d. | − 34d. |
| Rent, rates and taxes .. .. | 317 | ·13d. | 829 | ·21d. | + 08d. |
| Management expenses, salaries of managing engineer, secretary, clerks, &c, | 677 | ·27d. | 695 | ·18d. | − 09d. |
| General establishment charges, stationery and printing, law charges and insurance | 455 | ·18d. | 494 | ·12d. | − 06d. |
| Other expenses .. .. | — | — | 336 | ·08d. | + 08d. |
| **Total costs ... ...** | £4,929 | 1·99d. | £6,602 | 1·66d. | − 33d. |

**Last year we were able to say that the surplus for 1897 was more than doubled in 1898, and although it was not to be expected that this statement could again hold true, an increase of about £400 is most satisfactory, particularly as no charge (like "cost of altering circuit" last year) has to be put against it.**

PROFIT STATEMENT.

| | 1898. | 1899. |
|---|---|---|
| Interest on loans .. .. .. .. | £2,602 | £3,647 |
| Sinking fund for repayments .. .. | 1,898 | 2,565 |
| Net profit carried to depreciation account | 1,237 | 2,829 |
| „ cost of altering circuit .. .. | 1,200 | ... |
| Gross profit .. .. .. .. | £6,937 | £9,041 |

matter of importance. The sum of £6,000 was also expended on machinery, tools, and factory appliances. These sums included a large engine and boiler which had been erected. The engine was sent out early last year, but unfortunately the great demand in Germany for engineering goods precluded the delivery until late in the summer of certain parts which had to be made on the spot, and so they did not obtain the power anticipated during the dry season. With reference to the trade done during the year, the sales showed a considerable increase, but on the other hand both wages and stores, which include coal, increased out of proportion to the trade done. The prosperous state of trade in Germany created a large demand for labour, and it was found that the best men were leaving and obtaining higher wages elsewhere, so that there was no alternative but to comply with the demand and increase the rate paid. The same cause was responsible for the demand for coal which, coupled with a coal strike, increased the amount paid for coal by £750. It was estimated that the trading profit would amount to over £21,000, whereas it amounted to only £18,200. Had the amount of such estimate been realised, they would have been able to pay a dividend of 10 per cent. on the preference shares of the Austrian Company. The turnover was over £80,000, but the bad debt account amounted to only about £6. The working of the past year had, notwithstanding the difficulties encountered, given considerable cause for congratulation. The demand showed that the goods were being appreciated. This was perhaps exemplified more clearly than anything else by the fact that although the contract with the Government expired in March last they intimated their desire to continue for another year at the same prices. This contract was a sliding scale contract, that is to say, that the prices move with the price of raw copper. In addition, orders have been received from the principal shipyards of Germany, and in fact the company has now practically all the principal consumers of copper products on its books, and at the present moment orders are on hand far in excess of anything the company ever had before. The actual profit made in 1898 by the "Metall" Company, after deducting the £3,202 brought forward from 1897, was £5,193, whereas in 1899, after deducting the amount brought forward from 1898, the net profit was £6,310, notwithstanding the greatly increased cost of manufacture. This result was satisfactory, and there was every reason to anticipate that the current year, with the increased margin between raw copper and the price received for the finished article, the increased demand and the increased capacity of the factory, should show a much better profit. The company was exhibiting at the Paris Exhibition. It was not at first intended to do so, but they were approached by the Government who stated that they would be prepared to pay the cost of the site, &c., and that it was their wish that the company should exhibit if possible. He regretted to record the death of Lieutenant-General Fraser, who was a director of this company from its inception. Mr. Charles Garnett has been elected a member of the Board.

The adoption of the report was seconded by Mr. C. GARNETT, and carried unanimously after several questions had been put.

The CHAIRMAN, in replying to the questions, said he thought that they had gone through the worst period of any loss they were likely to suffer from the rise in the price of copper. This year their prices were likely to be higher and they would not suffer so much loss, if they suffered any loss at all, because every year the company was in a stronger position. Every year they got better contracts and were able to pick and choose their orders. The manager had made arrangements to keep the works supplied with coal. It was not a good quality, but it was the best they could get. He hoped they would have a season with more rain and would not have to use so much coal.

The resolution declaring dividend on the preference capital was also passed.

COMPARATIVE ANNUAL STATEMENT FROM THE COMMENCEMENT OF THE UNDERTAKING.

| Year ended | No. of consumers. | No. of 8-c.p. lamps connected. | B.T. units sold. | Income. | Expenditure. | Balance. Deficiency paid from borough fund. | Balance. Surplus. | Rate in £. |
|---|---|---|---|---|---|---|---|---|
| | | | | £ s. d. | £ s. d. | £ s. d. | £ s. d. | d. |
| Dec. 31st, 1893... | 112 | 9,613 | 43,224 | 1,067 3 11 | 3,614 11 8 | 2,547 0 0 | ... | $1\frac{2}{5}$ |
| „ „ 1894.. | 214 | 15,342 | 156,169 | 3,560 8 7 | 5,625 13 4 | 2,065 0 0 | ... | $1\frac{1}{2}$ |
| „ „ 1895... | 280 | 20,889 | 227,753 | 5,351 5 0 | 6,724 9 0 | 1,373 0 0 | ... | $0\frac{4}{5}$ |
| „ „ 1896... | 385 | 28,983 | 304,163 | 6,864 2 5 | 6,429 13 4 | ... | 434 9 1 | |
| „ „ 1897... | 598 | 41,702 | 438,648 | 9,060 12 1 | 7,876 12 1 | ... | 1,184 0 0 | Transferred to depreciation and contingencies account. |
| „ „ 1898... | 806 | 54,154 | 593,377 | 11,866 11 2 | 9,429 9 11 | ... | 2,437 1 3 | |
| „ „ 1899... | 1,082 | 70,178 | 951,033 | 15,642 15 7 | 12,813 19 7 | ... | 2,828 16 0 | |

# CITY NOTES.

## Elmore's German and Austro-Hungarian Metal Company, Limited.

THE ninth annual meeting of this company was held on Monday at Winchester House, Mr. JOHN MACFARLAN presiding.

The CHAIRMAN stated that during the year they issued £15,000 of debenture stock, which brought the total to the full amount they were authorised to issue. It was found necessary to place the stock in order to provide for the increased value of the copper stock of the "Metall" Company, caused by the great rise in the price of the raw material, and to carry out further extensions at the factory necessary to cope with the greatly increased demand for the products of the company. They also issued preference shares bringing up the total amount to £50,000, partly by the option mentioned in the accounts for 1898 having been exercised, and partly by the allotment of 675 shares to an applicant for a considerable amount of debenture stock. The £2,000 loan from bankers which was owing on the 1st January, 1899, was paid off, and the balance advanced by way of loan to the "Metall" Company. The increase in the total amount of charges for the year is due to an increase of £1,349 debenture interest and other sums for increased patent law and audit charges, and directors' fees. Mr. Prescblin, the manager in Germany, had invented a joint for high pressure copper tubes which they thought would prove to be of great value, and a considerable amount had been expended in testing the joint in order to prove its value to the Board of Trade in England. These tests by Messrs. D. Kirkaldy & Company had given most satisfactory results, and the company was now putting the joint before the great users in England with a view to its adoption. It was deemed advisable to pay the whole of the charges incurred in patenting and testing the invention out of revenue. Other items of profit and loss showed a considerable decrease. They had hoped that t' e result of the past year would have been sufficiently good to enable them to convert the debenture stock, on which they have to pay the ridiculously high figure of 8 per cent. interest, for a 5½ or 6 per cent. stock; but they felt that, as things turned out, they would not be justified in making the experiment, and they must ask the debenture holders to again postpone redemption for another year. Turning to the "Metall" Company's accounts, the sum of £3,560 was expended on additions to land, buildings and water-power. These additions consisted largely of new buildings which were required to house 32 full sized tanks, in addition to which space had been provided for centralising the making of mandrels, a

## The Western Telegraph Company.

THE fifty-third ordinary general meeting of the shareholders of this company was held on Wednesday at Winchester House, Old Broad Street, Mr. W. S. ANDREWS, the chairman, presiding.

In proposing the adoption of the report, the CHAIRMAN said that he thought the shareholders would agree that the report was particularly satisfactory, because it showed a continued increase in their receipts. The income for the half-year ending 31st December, 1899, including the dividends for the Western and Brazilian Company, and other companies, amounted to £139,596. The previous half-year the total reached £119,360, so that they would see there was an increase of £20,236. That increase resulted from an increase in the message receipts, and as a matter of fact the increase from messages amounted to £22,381, but as there was a diminution in the receipts from dividends of £2,145, the net increase was £20,236. They got most of the increase in traffic

receipts from South America, and there had been a small decrease on the South African coast. The expenditure amounted to £25,596, and that for the previous half-year was £21,999, so that there was an increase of £3,597. Practically the whole of that increase had been occasioned by the repairs to cables, which item exceeded by £3,100 the amount spent under the same heading for the preceding six months. Of course, that was an item which was not within their control at all. Breakages to their cables resulted from various causes, and when they happened, they must repair the cables as quickly as possible, so that it did not interfere with their profit. After payment of £3,200 for debenture interest and sinking fund, and providing for the payment of income tax, the credit balance of the half year amounted to £109,284. To that they had to add £5,062, the balance brought forward from June, making £114,346. There had been further expenses amounting to £176 in connection with carrying out the arrangements for a closer working union with the Western and Brazilian and the London Platino-Brazilian Telegraph Company, and the first and second interim dividend, amounting to £62,379, had been paid. That left them with a balance of £51,791. They had transferred £45,000 to the reserve fund, which left them with a balance of £6,791 to be carried forward. That seemed to him to be a pretty satisfactory state of affairs. It was an agreeable thing to know that since their last meeting the remaining interests of the shareholders in the Western and Brazilian Company had been acquired, so they might look upon it that they were not only under one roof, but they were one institution, and henceforward they would not hear of the Western and Brazilian Company but of the Western Telegraph Company. As to the future it never did to prophesy, but as far as they could gather they heard very good accounts of what was likely to be the state of the United States of Brazil for some long period to come. The country seemed to have taken a turn for the better, and after passing through its darkest period it seemed to be emerging into the light. There was a rising change, an increase in the general business and also an increase in their business in that country, all of which pointed to a satisfactory future. Consequent upon the amalgamation, they had begun the laying of a new cable of an exceedingly excellent type which was to give them a high rate of speed right away from Pernambuco to the Plate. They were very pleased that the laying of that new cable appeared to coincide with what they were led to believe to be a revival in the country, and it looked therefore as though they had taken a step at the right moment. The laying of that cable would of course deplete the reserve fund, but for that money they would have a new additional direct line which was likely to prove very remunerative. In conclusion, the CHAIRMAN referred to the proposed alteration in the superannuation and pension fund by which it was proposed to reduce the retiring age from 60 to 55 years. He said that it was not intended to retire all their clerks at 55, but they wished to have the power of doing so if they thought it advisable to exercise it in the interests of the company. In order to bring about the change the contributions by the staff and the company to the fund would have to be increased from 2½ per cent. to 4 per cent. respectively.

Sir ALBERT J. L. CAPPEL seconded the resolution, which after a short discussion was agreed to, and subsequently the necessary resolution was passed with reference to the pension fund.

## London Platino Brazilian Telegraph Company.

THE twenty-second ordinary general meeting of the shareholders of this company was held on Tuesday at Winchester House, Mr. W. S. ANDREWS in the chair.

In proposing the adoption of the report, the CHAIRMAN said that the income for the year 1899 was £29,643, which compared somewhat unfavourably with the receipts for 1898, when they received £36,288. Therefore there had been a decrease of £6,645 in the receipts of 1899, as compared with those of 1898. Really there had been an increase in the cable receipts in 1898 of some £660, but there had been a decrease in land line traffic of £7,328, which arose from exceptional circumstances, viz., that in 1898 they received from the Government a payment of £5,000 odd for night services performed during the disturbance. The expenses for 1899 were £6,832, and for the previous year £8,312, showing a decrease of £1,480. The feature of that decrease was that much of it was permanent in character, having arisen from the consolidation of the businesses, whereby a saving in salaries had been effected. The profits in 1899 had amounted to £23,531, as against £27,583 in 1898, or a diminution of about £5,000. Including the balance brought forward of £2,859, the amount available on 31st December last, after payment of the debenture interest, was £19,390. An interim dividend of 4s. 6d. per share was paid in respect to the June half of 1899, which absorbed £8,448, and it was now proposed to pay a further dividend of 2s. 6d. per share, amounting to £4,693, making altogether £13,441. That made the same distribution for 1899 as for 1898, and left a balance of £6,249, for which they had made a transfer to the reserve of £5,000, and carried forward £1,249.

Mr. J. DENISON PENDER seconded the motion, and the report was adopted.

## The West Coast of America Telegraph Company.

THE third ordinary general meeting of the shareholders of this company was held on Tuesday last, at Winchester House, Old Broad Street, Mr. J. DENISON PENDER presiding.

The CHAIRMAN, in moving the adoption of the report, said they would see by the accounts that the receipts for the year were £28,347 as compared with receipts in 1898 of £25,080, thus showing an increase of £3,267. That satisfactory result had of course been chiefly derived from the increase of traffic which had come from a revival of trade on the coast, and the exchange, which had gone up from 12½d., which was about the average of 1898, to 16d., which had been the average for 1899. But having regard to the increase in the receipts, naturally they would turn to the expenditure and see if there had been an increase there. He was sorry to say that there had been an increase in the expenditure, but that had been impossible to avoid. The total expenses of 1899 were £21,065, and in 1898 they were £18,840, thus the increase had been £2,224. The cause of that expenditure chiefly had been the repairs of cables, and of course where you had got repairs they had the very material cost of the new cable which was put in. Also with regard to the ship. As they knew, they got a rebate for every week she was lying in harbour doing nothing. During the twelve months under review the ship had been out more than usual, therefore the cost of insurance had been considerably greater, to say nothing of the increased cost of coal, of which everyone was aware. The sections under repair had been the Serena Valparaiso, which was repaired in March and again in August. The cause of the interruption there was found to be the bad ground that the cable was laid upon, which was very rocky. The position had been removed further seaward, and he thought they had now got better ground, and therefore the cable was not likely to be interrupted again. The other repair had been the Caldera Serana cable which was repaired in February and in the beginning of March, and again at the end of March. The latter repair was caused by a land slip which made the cable taut and put a fault in it. Another repair had been the shore end of the Antifigusto cable, which had been renewed. With regard to the expenses, as he had mentioned before, it entirely depended upon the cable repairs they had. If they were fortunate enough one year to have a low expenditure under that head they could not count upon its continuance, because the next year might bring, as the last twelve months had done, a considerable increase in that item. With regard to the balance—£3,267—that had been dealt with by the payment of interest upon the income bonds. They would remember that those bonds were issued at the time of the reconstruction of the lay. They were taken by the Brazilian companies and some were also taken by the Construction Company. The interest upon these bonds was not cumulative, and for two years they had not paid any interest. This year he was glad to say that they had been able to pay out of profits the full 4 per cent., and that was a move in the right direction. During the year they had taken the cable out of Caldera and closed that office, because it did not pay its expenses. The public would not suffer in the least, because there was a Government land line, and traffic would be handed to the Government, and the messages which were to come to Europe or other parts of the world would come on to their lines at one of the other stations. If the political situation in South America remained quiet, as they had every reason to hope, they hoped that the present satisfactory figures would be exceeded in future years.

Sir ALBERT J. L. CAPPEL seconded the resolution, and the report was adopted.

## Submarine Cables Trust.

THE annual meeting was held on Tuesday at Winchester House, the Marquis of Tweeddale presiding.

In moving the adoption of the report, of which we gave a brief abstract last week, the CHAIRMAN said that the income for the year was £24,789, or an increase of £3,333. The principal cause of that apparent increase was that they had received and brought into the credit of revenue a full year's dividend and bonus on the shares of the Eastern Extension Company, amounting to £9,294, whereas only three full quarters were carried to the credit of revenue last year. Various other differences made it difficult to compare the dividends of the current year with the previous year, owing to the dates of the receipt of dividends being variable. That was the case with the American investments, but the differences were fully explained in the accounts. After deducting the expenses of the Trust, there was an available balance of £23,601, which had been sufficient to pay two coupons of £3 each, and leave a balance of £3,315. The surplus funds were to be used in the redemption of certificates, either by purchase in the open market, provided that the price paid for each certificate was less than £120, secondly by the certificate holders; failing those two methods by drawing at £120. The trustees drew twenty-seven certificates on Friday, 27th ult., 1900. Particulars of the changes made in the investments were given in the report. They were very few, and consisted practically of the sale of some of their American holdings, in order to enable them to take advantage of the offer of the Commercial Cable Company of a number of this company's shares at par. It had been a very profitable transaction to the Trust. Mr. Clements S. Colvin, C.S.I., had been appointed a trustee.

Mr. J. D. PENDER seconded the resolution, which was carried.

## Great Northern Telegraph Company.

The following is an abridged report of the general meeting held at Copenhagen on 28th April, when Mr. F. ZAHLE presided.

The Chairman and Managing Director, Commodore E. SUENSON, D.R.N., in rendering an account of the working of the company during the year 1899, made the following remarks:—*The Company's Cables.*—During the first half of the year 1899 the condition of our cables was most satisfactory, whilst in the latter half numerous interruptions occurred, especially in Europe. Twenty interruptions have affected eleven of the European cables, and in the Far East

there had been nine interruptions of six cables. Upon the whole, however, the number of interruptions compares favourably with that of the preceding year. The cable steamer "H. C. Orsted" has been employed on active service for 194 days, and the "Store Nordiske" for 87 days, of which 25 were for the account of others. *The Wladiwostock Line.*—The efforts of the Imperial Russian Administration to improve the Wladiwostock Line have commenced to bear fruit, and although there is still room for improvement of this line, the number of telegrams forwarded shows an appreciable increase. *Danish Concessions.*—On the expiry of our Danish Concessions for the establishment and working of cables connecting Denmark with Norway, Great Britain and Russia, the Danish Government extended the same with certain modifications, the former to the 1st of January, 1911, and the latter to the 31st of December, 1912. *The Projected Iceland Cable.*—At the meeting of the International Meteorological Committee, held at St. Petersburg in September last, the project for a submarine cable to connect Iceland with the telegraphic system of the world was again brought forward by the Danish Meteorological Office. As at several previous Meteorological Congresses, the scheme was favourably received, the Committee, by a special resolution, urging the Danish Government to continue their efforts in the same direction as hitherto for the realisation of the project. *Protection of Submarine Cables.*—The Danish Government were less successful in their endeavours to induce the Peace Congress, assembled at the Hague in May and June last, to deal with the question of the legal status of submarine cables in time of war. The importance of the question raised was, however, generally recognised, and it cannot fail to engage the serious attention of a future Congress. *Affairs in the Far East.*—In the Far East, where we have obtained an extension till 1911 of the privileges previously granted us by the Chinese Government, the China traffic has attained the same level as during the preceding year, whilst the Japan traffic shows even an increase. If this satisfactory state of affairs be maintained during the present year, there may be occasion to take up the question of a further revision of rates for telegrams to the Far East at the International Telegraph Conference to be held in London next year, although the last reduction of these rates took place as recently as the 1st of July, 1897. *Amortization of 1883 Debentures.*—The remaining £70,000 of our 5 per cent. debentures of 1883 having been paid off on the 1st March, 1899, these debentures, together with the extraordinary amortization fund set aside for their redemption, will hereafter not appear in the balance sheet. *Receipts of the Company.*—The excellent results of the year place us in a position to propose the same extra dividend as last year, viz.: 7½ per cent. (making 12½ per cent. in all for the year), and at the same time to increase the Reserve and Renewal Fund by a substantial amount. On the other hand, we have had to charge some large amounts against this fund, partly because of the depreciation of a great number of the bonds belonging to the same—a depreciation which has reduced the value of the investments, at least for the present, by £40,075 19s. 3d.—and partly because £171,864 9s. 9d. has been written off the value of our property in Europe and Asia. The principal cause and effect of these measures is to make the amount of the balance of the Reserve Fund—part of which has from time to time been used for the establishment of our lines, &c.—correspond to the amount of the securities of cash actually in hand for the account of the same. *Cable Schemes.*—The political events of the past year have more than ever emphasised the important part played by the great telegraphic highways in the political, commercial, and social development of the world. In addition to the old English and American schemes, whose principal object is the establishment of national and independent submarine lines in the Pacific, other schemes and projects with similar aims have sprung up in other parts of the globe. As yet it is difficult to disentangle the numerous ideas and projects, and to foretell the issue, but we confidently hope that, thanks to the political passivity and neutrality of the nation to which it belongs, and to the admitted discretion and impartiality of its service, the Company will continue to enjoy the confidence of all the Governments and Administrations whose territories its cables have connected for thirty years. Nevertheless, it is more than ever necessary to prepare for any contingency which may arise from the present complications by continuing the cautious financial policy which we have followed till now, and of which our account for 1899 is evidence.

The following resolutions were carried:—

"1. That the Report and Balance Sheet, together with the propositions as to the distribution of the Balance, be adopted and discharge given to the Board of Directors."

"2. That the retiring Director, Commodore E. Suenson, be re-elected as a member of the Board of Directors."

"3, That S. Bille, Esq., and S. Bulow, Esq., be re-elected as Auditors of the Company."

## Hampstead Electric Supply Company, Limited.

THE directors' report read as follows:—

The directors have pleasure in submitting to the shareholders their report and the statement of accounts to December 31st, 1899. The directors would draw attention to the items on the credit side of the balance-sheet amounting to £16,411 for property acquired since the formation of the company. Of this amount, plant and machinery absorbed £5,394 8s. 6d., and main cables £1,618 13s. 4d., horses and carriages £6,388 11s. 7d. The benefit of this large expenditure has not, however, been realised to any but a very small degree in the profit and loss account now under review. The full advantage will, however, appear in the accounts for the current year. The large stores, known as "John Barnes & Company, Limited," in the Finchley Road, was connected during the year for the supply not only of the lighting of the extensive premises, but of the motive power for the lifts in the building. This is equivalent to the consumption of 44,000 C.P., the benefit of which will only come in the accounts for 1900. The number of extra 8 C.P. lamps connected during the period under review was 6,687, equal to 52,896 C.P., making, with those previously mentioned, a total increase of 96,896 C.P. About 5 miles of additional cable have also been laid. In this connection it is gratifying for the directors to be able to record the fact that on no single occasion has the supply failed. Few electric light companies can make a similar statement. The profit and loss account shows the profit on electric lighting for 18 months to have been £5,105 19s. 8d., and the profit on Taylor & Lown's business for nine months to have been £1,229 18s. This portion of the company's business has not yet derived the full benefit from the large amount of new stock purchased in the past year. Taking into account the additional expenses which always have to be incurred on the inauguration of a new company, and the fact that the high price of coal has considerably reduced the profits, the directors consider that, for the first year's trading, these figures are very satisfactory. As to the future, the directors have every reason to feel very confident. Additional houses are being connected every week, and there are contracts in hand for the supply of some 500 houses. The capital outlay has practically ceased, but the income of the company will be increasing daily. The future profits available for distribution should therefore be larger year by year. With regard to the running of motors mentioned in the prospectus, the directors found that the motor vehicles the company had running in Hampstead did not work so successfully as could be wished, consequent on the difficulty of obtaining an efficient accumulator, and have therefore decided not to spend further money thereon, but to await developments. Immediately a satisfactory accumulator is obtainable, the company will be able to execute the orders they have already in hand, for the supply of motor vans, &c. This will provide an outlet for the sale of the day current, which is the most profitable part of an electric company's business, and thereby largely increase the future profits. The directors propose to carry forward the balance of profit to the next account. The auditors, Messrs. Hart Bros., Tibbetts, Heiron & Co., submit themselves for re-election.

THE annual meeting of this company was held on Monday afternoon at the Hampstead Conservatoire, Swiss Cottage, N.W., Mr. E. T. Read presiding.

In moving the adoption of the report and accounts, Mr. READ said that he occupied the chair because the Chevalier Shares, the chairman of the company, was suffering from a rather sore throat. He then proceeded to go over the balance-sheet and report. The actual amount of issued capital was £145 480, to which they must add the mortgage and debenture capital amounting to £35,000. Sundry creditors, £9,553, was the usual trade account which always existed in a company of this character. With the large business they had been doing, increasing at such a rapid rate they were always more or less in want of money, and they had overdraft and loan to the extent of £1,800. On the other side of the balance sheet it was shown that the purchase price amounted to £166,085. By the contract of purchase the company had to take over the assets of the Hampstead Battery Company, and discharge their liabilities and collect their accounts. That item was not yet closed and the amount of £1,085 would probably be materially reduced. They had expended during the period under notice £16,000 for increase of plant for both the businesses. That was an increase which gave satisfaction as an increasing plant and stock showed an increasing and progressive business. The amount due from sundry debtors was perfectly good as they were very little troubled with bad debts. In regard to the experiments on motor cars, &c., one of the future outlets for their day current would be the supply of current to motor cars. It would be a very profitable source of revenue, but up to the present accumulators used for motor cars were very heavy and did not satisfy the requirements of light vehicles. The London Electrical Cab Company found that they had to stop temporarily—he hoped not altogether—but they had to stop running their carriages because the accumulators were so very heavy and would not contain the requisite amount of electric current to enable them to run with satisfaction. The difficulty of motor car stoppages at inconvenient moments was the difficulty that was being overcome. He had not the slightest doubt that in a very short time an accumulator would be found that would be all that was required. The preliminary expenses might be considered a very heavy item, but the greater proportion was the very large amount of stamp duty and registration expenses. Those expenses had to be paid by the company in accordance with the prospectus. They were being gradually written down. The directors' fees were reduced voluntarily, and they would be kept down until the company could comfortably afford to pay the authorised fees. Turning to the directors' report, so far as the electric lighting portion of the business was concerned, their capital expenditure was practically finished for a certain period. He thought that for some little time they would not have to spend any more on capital account. During the last 12 months they added about 200 houses to their custom roll, and at the end of the last year the large stores of Messrs. Barnes were connected, these premises being fitted with lamps to the equivalent of 44,000 C.P. They would also take motive power for their lifts. They had 500 houses under contract being gradually connected, and this gave a certain increase of trade from that source alone for the next two or three years. There were many other estates going to be built over, and the houses on these would also be supplied when erected. They had not had a single breakdown; some time ago some railway men broke down one of the company's wires and caused a breakdown for an hour, but that was not the company's fault. The profit and loss account showed that for the 13 months the profits were over £5,000. The profits would have been greater but for the rise in the price of coal. The price of coal had now gone down, but they had been taking measures to test certain mechanical contrivances by which in the event of coal maintaining its high price they would be able to burn an inferior class of coal without making a tremendous smoke. So far the experiments had answered admirably, and they had been able to save money by burning second-class coal. As to the Taylor & Lown part of the business the profits were disappointing, but trade reasons were responsible. Those reasons had now been got over, and during the past four months the business had increased by 25 per cent., and the profits by 50 per cent. As to the disappearance of names from the directorate. Mr. Fawcus found his business engagements in the North of England prohibited him giving time to the business. Mr. Cave's own business required his constant personal attention, but though he had left the board they had the benefit of his connection. Mr. Evans, a very successful business man, had great calls upon his time, and had retired from the board, but they had the benefit of his advice when wanted. He himself (Mr.

Read) joined the board last year because he had such a very large amount invested in the company, that he thought he would like to be in a position to see that the thing became a success. As one of their largest shareholders, he said that they had a sound and progressive business, which if properly managed and provided with the sinews of war, should make a profit of anything from £10,000 to £15,000 per annum, within a short period. It was very exceptional for an electric lighting company to pay dividends until several years after its formation. They had had to pass the dividend for the six months ended December 31st, but that dividend was cumulative. They had not as much money as they needed to enable them to push the increasing business alone. They were taking steps to provide for that necessity.

The adoption of the report was seconded by the Chevalier SOARES.

A SHAREHOLDER asked when Mr. Armstrong left the board, and in reply, the Chairman said, that a fresh arrangement had been made with him, by which he remained consulting manager instead of being managing director.

In reply to other questions it was stated that out of the £160,000, if they took half the capital, and put it down as plant, machinery, freehold, &c., and put the other half to goodwill, they would be approximately correct. A shareholder said that the prospectus stated that the preliminary expenses, £2,893, were to be paid by the vendor. Shareholders proceeded to quote from the prospectus, and to carry on a cross-examination of the chairman, declaring the prospectus to be misleading. Sir Thomas Delarue it transpired was the holder of a £5,000 mortgage at 5 per cent.

Mr. PARKER, another shareholder, proceeded to comment upon the way in which the original board had disappeared. The only excuse of the four directors leaving was that they were too busy. They must have known that when they came on to the board. Why did they leave and allow shareholders to take shares in this company, believing that they were to be supported by responsible men. There was change and decay apparent in the whole concern. The company was established in August, 1898, but they had had no account rendered until the end of April, 1900. Why did they tell shareholders in sending the report, that a report of the proceedings would be sent to the shareholders? Was it to keep them away from the meeting? Why bring them from the City to Hampstead, when the crew of the *Powerful* were welcomed there? The original prospectus gave them to understand that, practically speaking, they were to look for £18,000 profit. Did that mean at once or in the future?

In reply to further questions, it was stated that the amount of capital applied for was £72,000 originally, and the amount paid to the vendors was £50,000. The directors went to allotment on July 29th, 1898. Mr. Armstrong was to be paid his salary of £500 per annum for three years. The chairman thought it would be time and money thrown away to attempt to claim the return of any of the purchase money paid to the vendors.

Mr. PRESTON moved that a committee be appointed to confer with the directors and look into the affairs of the company, and to take legal proceedings if they thought necessary, and report to the company.

This having been duly seconded, and put to the meeting, the CHAIRMAN declared it lost on a show of hands, but he declined to count.

The report and accounts were also adopted on a show of hands, there being a number of dissentients.

The CHAIRMAN said, that why the meeting was held at Hampstead, was in order that shareholders might have an opportunity of inspecting the works.

There was some discussion as to the delay in publishing the accounts, and Mr. HEIROD, representing the auditors, replied to certain questions on the matter, after which Messrs. Hart Brothers, Tibbetts, Heirson & Co., were re-elected.

## Cuba Submarine Telegraph Company, Limited.

THE meeting of this company, held on Wednesday, at 58, Old Broad Street, was presided over by Mr. C. W. PARISH, who, in moving the adoption of the report, said he was sorry that the revenue account was by no means so encouraging as they had been accustomed to. It was in 1895 that the revolution in Cuba took a serious form. Up to that time the company was in full enjoyment of advantageous rates, and although they were reduced in 1898 on account of the competition from the New York and Hayti cable and the Bermuda-Jamaica cable owned by the Direct West India Company, the loss was more than compensated for by the increased business brought by the revolution and by the Spanish-American war, directly by the heavy Government work, and indirectly by the landlines being destroyed by the Cuban rebels, which caused a considerable increase of local business to be sent over the cables. At late meetings he had urged them to be prepared for reduced receipts, and they had not hesitated to strengthen the reserve fund as much as possible during the several good years they had enjoyed, so that they might be able the better to face the lean years that would be sure to follow when peace was restored. The revenue account showed that the actual traffic receipts for the half-year ended December 31st last amounted to £12,008, as compared with £25,740 during the corresponding half-year of 1898, a falling off of more than 50 per cent., which, as stated in the report, was due principally to the lower rates at which they were working, and to the competition of the landlines which have now been restored. During the last half of 1898 they were still dealing with a good deal of extra business, which was caused by the after effects of the war. The second item of the revenue account was a sum of £5,316, which they had received on outstanding, and was part of the amount received at Madrid from the Spanish Government, against a balance of certain accounts of Government messages sent during the war, and which had not been settled by the Spanish officials before leaving the island. They were treated by the directors in the accounts as outstanding. The third item of the revenue came from interest on investments and deposits, and amounted to £2,181, which was a larger sum than usual. Taking all sources of income together, they had received £19,512, against £24,483 in the corresponding period of 1898. The expenses in 1899 were £6,192, against £7,585 in 1898, a reduction of £1,393. They had carried £4,937 to reserve fund, bringing that account up to £130,000, and after paying preference dividend, they were able to pay 6 per cent. on the ordinary shares, which was not an unsatisfactory result. As to the state of the cables, the break in the Cape Cruz-Manzanillo cable was repaired without difficulty, but the section between Cienfuegos and Cape Cruz, which was laid in 1881, proved so extremely weak, that it was impossible to lift and repair it. That was a cable which was laid on the deferred payment system, which was not originally made for the company but had done them very good service. They had now one cable working direct from Cienfuegos to Santiago, and this line is practically duplicated by the company's coast cables. Mr. Keith and Mr. Scott had lately visited America in the interests of the company, and he was very glad they did so, for he believed that a considerable benefit would result from their journey. As to their present position towards the U.S. Government, there were three points which they were anxious to have settled. In the first place they would like the American Government to recognise their concessions which they had not yet done; secondly, they desired payment of their subsidy of £2,000 per annum due under their 1895 concession for the coast cables; and thirdly, there was a claim for £8,174, the cost of repairing the damage done to their property during the South American war. They turned to the Foreign Office, who had been most helpful to them in the matter, and negotiations are now being carried on by H.M. Ambassador at Washington with the U.S. Government, and as a result of those negotiations they had lately been informed by Lord Salisbury that the question of their concessionary rights and the arrears of subsidy had been referred to the U.S. Secretary of War, under whose department the matter was receiving attention; as regards the claim for £8,174 for damage done, President McKinley had asked the Senate and House of Representatives to reimburse the company the expenses they had incurred. Shareholders might have noticed in the newspapers a reference to the message that he sent, but so far they had not heard if that message had come up for discussion. However, their interests were being carefully looked after. They received the subsidy from the Spanish Government up to the end of 1898, but so far he had received no payment since, which really was a very great hardship for them, for they never would have laid the coast cables without the promised subsidy. When Mr. Keith and Mr. Scott were in New York they had the opportunity of discussing with the International Company their mutual interests, which was very advantageous. Their rates were very low, but they hoped as the state of the island improved that they might have the benefit of a somewhat increased business, though he would warn them, on the other hand, that trade seemed to be very bad in the West Indies, and there appeared to be no expansion of the traffic from that source. As far as the receipts had gone for this year, they appeared to be much the same as for the last six months of last year.

Mr. KEITH seconded the adoption of the report, which was carried, as was also a resolution declaring the dividends.

## Prospectuses.

A PROSPECTUS has been circulated inviting applications until May 10th (yesterday) for £100,000 in £1 ordinary shares, and £10,000 in 5 per cent. first mortgage debentures in Royles, Limited, of Manchester. Accompanying the prospectus is a catalogue of the various apparatus, &c., supplied to steam users by Messrs. Royles. These include evaporators, condensers, feed-water heaters, calorifiers, steam traps, dryers, ovens, and so on. The nominal capital of the company is £150,000 in £1 shares, and £20,000 debentures. The company takes over the engineering business of J. J. Royle, Dalham Works, Great Bridgewater Street, Manchester. The vendors take £91,867, as to £65,000 in ordinary shares, £5,000 in debentures, and the balance in cash.

The Dover Electricity Supply Company has been offering for subscription an issue of 1,500 5 per cent. cumulative preference shares of £6 each at a premium of 25s. per share.

## James Hinks & Son.

THE report for the year ending March 31st, states that the net profits amount to £10,992, giving, with the balance brought forward, £13,836, which it is proposed to apply as follows:—Sinking fund for redemption of buildings and plant, £1,091; general reserve fund, £2,000; interim dividend at 7½ per cent. per annum, £2,430; final dividend, half-year to date, at the rate of 12½ per cent. per annum (making 10 per cent. for the year), £4,051; bonus, 1 per cent. free of tax, £670, carrying forward £3,594

## New General Traction Company, Limited.

THE report of the directors for the year ended March 23rd, states that the gross profits were £76,299, after deducting £6,116 10s. 6d., the amount of general expenses, salaries, &c., chargeable against revenue. To this has to be added the sum brought forward from last year, making a total of £82,512. A dividend at the rate of 6 per cent. on

the outstanding preference capital for the past year from the dates of payment will be paid on May 15th, and after providing for this a balance of £68,742 remains, which the directors propose shall be dealt with by transferring £10,769 to reserve against goodwill, £943 to meet the difference of the present market value of Consols purchased and lodged as caution money and the price at which they were bought, and £20,000 to the general reserve account. This leaves a balance of £37,030 to be carried forward to next year. In addition to the amount credited to reserve against goodwill from this year's revenue, the directors have transferred to the credit of this account £2,230 standing to reserve in last year's accounts, this being profit of the old company and included in the purchase price and not, therefore, available for revenue purposes. With this addition the amount at credit of reserve against goodwill stands at £13,000.

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**Stock Exchange Notices.**—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to:—British Insulated Wire Company, Limited—Further issue of 30,000 ordinary shares of £5 each, and 30,000 6 per cent. cumulative preference shares of £5 each; and to allow the following securities to be quoted in the Official List:—Cape Electric Tramways, Limited—Shares of £10 each. They have also appointed special settling days as under:—Tuesday, May 15th: British Aluminium Company, Limited—£300,000 5 per cent. first mortgage debenture stock. Wednesday, May 23rd: Crompton and Co., Limited—Further issue of 7,582 ordinary shares of £3 each, fully paid, Nos. 46,419 to 54,000. National Telephone Company, Limited—81,092 ordinary shares of £5 each, £3 10s. paid; 18,908 ordinary shares of £5 each, fully paid (within Nos. 490,001 to 590,000); and fully and partly paid provisional certificates for £500,000 4 per cent. debenture stock. The British Aluminium debentures mentioned are also ordered to be officially quoted.

## TRAFFIC RECEIPTS.

**Blackpool and Fleetwood Tramroad Company.**—The receipts for the week ending May 5th, 1900, were £333 6s. 11d.; receipts for corresponding period, 1899, £419 6s. 5d.; aggregate for half-year to date, £4,252 7s. 6d.

**The Bristol Tramways and Carriage Company, Limited.**—The receipts for the week ending May 4th, 1900, were £2,881 3s. 6d.; corresponding period, 1899, £2,815 5s. 1d.; increase, £65 18s. 5d.

**The City and South London Railway Company.**—The receipts for the week ending May 6th, 1900, were £1,293; ditto May 7th, 1899, £995; increase, £298. Total receipts for half-year, 1900, to date, £22,245; corresponding period, 1899, £19,317; increase £2,928. Miles open May 6th, 1900, 3½; May 7th, 1899, 3½.

**The Dover Corporation Tramways.**—The receipts for the week ending May 5th, 1900, were £189 5s. 10d.; May 6th, 1899, £151 11s. 5d.; increase, £37 14s. 5d. Total receipts to date, 1900, £2·42 19s. 3½d.; corresponding period, 1899, £2,731 9s. 5d.; increase, £111 9s. 10½d. Miles of track open, 1900, 8; 1899, 8. Car miles run, 1900, 4,934; 1899, 4,127. Number of cars, 1900, 11; 1899, 11.

**The Dublin United Tramways Company.**—The receipts for the week ending Friday, May 4th, 1900, were as follows:—D. U. T. Co., horse cars £55 9s. 4d.; ditto, electric cars, £3,421 11s. 0d.; D. S. D. Co., electric cars, £804 7s. 7d.; total, £4,281 7s. 11d.; corresponding week last year—D. U. T. Co., horse cars, £1,900 13s. 10d.; ditto, electric cars, £1,086 4s. 2d.; D. S. D. Co., electric cars, £772 19s. 4d.; total, £3,759 17s. 4d.; increase, £521 10s. 7d. Aggregate to date, £71,887 1s. 11d.; aggregate to date last year, £59,724 9s. 5d.; increase to date, £12,162 12s. 6d. The mileage worked is 42 miles electrically, 2 miles by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

**The Halifax Corporation Tramways.**—The receipts for the week ending May 5th, 1900, were £632; week ending May 7th, 1899, £461; increase, £171. Total receipts to date, 1900, £3,297; ditto. 1899, £2,226; increase, £1,071. Number of cars, 1900, 28; 1899, 15. Miles of track open, 1900, 12; 1899, 6½.

**The Liverpool Overhead Railway Company.**—The receipts for the week ending May 6th, 1900, amounted to £1,433; corresponding week last year, £1,426; increase, £7. Total increase in traffics for half-year to date, £1,047.

**The South Staffordshire Tramways Company.**—The receipts for the week ending May 4th, 1900, were £708 19s. 6d.; May 5th, 1899, £628 1s. 4d. Aggregate receipts for 18 weeks, £11,597 16s. 9d.; last year, £11,095 15s. 2d.

## STOCKS AND SHARES.

Wednesday Evening.

With the solitary exception of the Kaffir Circus, markets in the Stock Exchange have been undergoing an unpleasant experience this week, and falls have been the order of the day in nearly every department. The reason for this is the extreme firmness of the money market and the improbability of its slackening for some months to come, when the resumption of gold exports from South Africa may be fairly expected. With the banks offering 3½ per cent. for money on deposit, investors are not likely to be dazzled at the prospect of getting that rate, or less, upon Stock Exchange securities whose most likely course of progress, as regards price, will be a retrograde one for a month or so. And as there are only a very few sound electrical undertakings whose shares yield anything over 4½ per cent., it is not very surprising that, in the present condition of affairs, there are few rises to record.

To particularise, City of Londons are 10s. better upon the successful issue of the company's case—a result upon which it deserves congratulation. The rise was, however, more sentimental than otherwise, because there has been no influx of buyers to produce the advance—not so much, in fact, as there has been for Westminsters, which mark a similar rise, the market discounting the upshot of the meeting. Charing Cross have again developed weakness, partially for the same reason which gave fresh strength to City of Londons. County Preferences have not yet recovered their fall of last week, and the company's 4½ per cent. Debenture stock is rather offered. We alluded last week to the pitiable condition of the Hampstead Electric Supply Company; the directors' report does not tend to raise the proprietors' spirits to any extent, and we fear that a drastic re-arrangement of the company's capital will have to be resorted to before the concern can be placed on a permanently payable basis. But for a while it should be given a further trial in its present state.

Electrical railway stocks and shares have not participated as much as might have been expected in the slump which has come over the Home Railway department, owing to the coalowners' action in threatening to raise the price of locomotive coal from 10s. per ton to 15s. This rumoured decision was the signal for a regular rout in Home Railway securities, in which the electrical shares were, to a small extent, involved. Of course, the raising of the price of coal, even if it be confirmed, will not affect the latter to anything like the same degree as it will damage such stocks as Great Northern, North-Western, or Midland. City and South London, however, fell another three points, making 6 per cent. during the fortnight, but Central Londons are unchanged. The market is now seriously debating the application of electric traction to the great trunk lines, but there is a wider-spread feeling that petroleum would cost less as a motive power than electricity.

Waterloo and City Ordinary stock remains at par upwards, and we would suggest that the present is an opportune time for holders to realise and to buy something which stands more chance of a rise in the near future; for Waterloo and City can scarcely pay more than 3 per cent. for the next year or two, and if money justifies our prediction of remaining stringent, the price of its stock will have to drop until it reaches a level at which the investor will get at least 3½ per cent. At 86 this yield would be obtainable, and we should not wonder at seeing Waterloo and City decline by gradual stages to the neighbourhood of 90. Its safety will always make it worth a little more than the Ordinary stocks of other Home Railways.

British Electric Traction have followed up their fall of £1 last week by another of half that amount, the Preference declining ½ at the same time. The "market" in the Stock Exchange has got more shares than it wants, that is the secret of the decline, and nobody comes in to reduce the superfluity. While the British Electric Traction shares are weak, a very different state of affairs prevails across the Channel, where the Paris Bourse has been indulging in a boom in electric tramway shares. Public enterprise in Paris is mad over tramways just at present, but the only English concern which is deeply interested in any of the schemes is the Exploration Company, whose ramifications extend from one end of the globe to the other.

The suspension of the boom in American rails has caused a sympathetic decline in Anglo-American Telegraph Deferred stock, and in Direct United States cable shares. In Anglo "A" a somewhat overheavy bull account has been built up, and the weakness now is natural. The company, we have excellent authority for stating, has so far done rather better than it did last year. Direct Spanish shares appear worthy of a little attention, the Preference more particularly. These carry a 10 per cent. cumulative dividend, and can be bought at a trifle under £10, the return at that price being 5 per cent. According to lately published statistics, the American War has proved a blessing in disguise to Spain, because of the renewed activity that has been awakened through it in the mother country, now shorn of nearly all her colonies. Oriental Telephones have crept a fraction over par, but Nationals exhibit no change. The Eastern market is sigularly quiet, purchases and sales almost balance each other day by day. Eastern Extension 4 per cent. Debenture has fallen 2 per cent., and a similar fate will probably overtake the senior securities of electrical undertakings, unless the money market becomes easier.

Although the report of the New General Electric Traction Company shows that a gross profit of £76,299 has been made for the year, the directors declare no dividends on the Ordinary shares. A sum of £37,000 is carried forward to next year, and this is equal to over 30 per cent. on the Ordinary capital, yet the proprietors are to receive nothing on these last. The balance-sheet contains a credit amount of £366,473 for shares and mortgage bonds, and two-thirds of this is represented by shares at par, which have been taken in part payment of work done. Why these should not be valued at their market worth we fail to understand, but this item is probably the reason why the directors feel it incumbent upon them to carry forward such an enormous sum. It seems to us a pity that the accounts are not presented in a form that would enable the shareholders to comprehend better the position of their company.

## SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

| Present Issue. | NAME. | Stock or Share. † | Dividends for the last three years. 1897. | 1898. | 1899. | Closing Quotation, May 2nd. | Closing Quotation, May 9th. | Business done during week ended May 9th, 1900. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 110,900 | African Direct Telegraph, 4 % Debs. | 100 | ... | ... | ... | 100 —104 | 100 —104 | ... | ... |
| 125,000 | Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. | 100 | ... | ... | ... | 85 — 90 | 85 — 90 | ... | ... |
| 875,520 | Anglo-American Telegraph | Stock | 3 % | £3 9s | 73/6 | 62 — 65 | 62 — 65 | ... | ... |
| 3,062,240 | Do. do. 6 % Pref. | Stock | 6 % | 6 % | 6 % | 114½ —115½ | 114 —115 | 115⅜ | 114½ |
| 3,062,240 | Do. do. Deferred... | Stock | ... | 18s. % | £1 7s | 14¼— 14⅜ | 13⅜— 14¼ | 14⅜ | 13 11/16 |
| 44,000 | Chili Telephone, Nos. 1 to 44,000 | 5 | 4 % | 3 % | ... | 2⅛— 3⅛ | 2⅛— 3⅛ | 2⅛ | ... |
| 10,000,000$ | Commercial Cable | $100 | 8 % | 8 % | ... | 165 —175 | 165 —175 | ... | ... |
| 1,563,078£ | Do. do. Sterling 500 year 4 % Deb. Stock Red. | Stock | ... | .. | ... | 102 —104 | 102 —104 | 103 | ... |
| 16,000 | Cuba Telegraph | 10 | 7 % | 8 % | ... | 9 — 10 | 9 — 10 | 10 | 9¼ |
| 6,000 | Do. 10 % Pref. | 10 | 10 % | 10 % | ... | 19 — 20 | 19 — 20 | ... | ... |
| 12,931 | Direct Spanish Telegraph | 5 | 4 % | 4 % | ... | 4 — 5 | 4 — 5 | ... | ... |
| 6,000 | Do. do. 10 % Cum. Pref. | 5 | 10 % | ... | ... | 9 — 10 | 9 — 10 | ... | ... |
| 80,000 | Do. do. 4½ % Debs. | 50 | ... | ... | ... | 101 —105% | 101—105% | ... | ... |
| 60,710£ | Direct United States Cable | 20 | 3½% | 3½% | 3 % | 11⅛— 12¼ | 11⅛— 12 | 12⅛ | 11⅛ |
| 120,000 | Direct West India Cable, 4½ % Reg. Deb. | 100 | ... | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 4,000,000 | Eastern Telegraph, Ord. Stock | Stock | 7 % | 7 % | ... | 150 —155 | 150 —155 | 153 | 150 |
| 1,795,000 | Do. 3½% Pref. Stock | 100 | ... | ... | ... | 98 —101 | 98 —101 | 99¼ | 98 |
| 1,432,268£ | Do. 4 % Mort. Deb. Stock Red. | Stock | 4 % | ... | ... | 114 —119 xd | 113 —118 | 113 | ... |
| 250,000 | Eastern Extension, Australasia, and China Telegraph | 10 | 7 % | 7 % | 7 % | 15⅞— 16¼xd | 15⅞— 16¼ | 16 1/16 | 15⅞ |
| 6,700£ | Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326 | 100 | 5 % | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 26,600£ | Do. do. Bearer, 1,050—3,975, 4,327—6,400 | 100 | 5 % | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock | Stock | 4 % | ... | ... | 115 —120 | 113 —118 xd | ... | ... |
| 300,000£ | Eastern and South African Telegraph, 4 % Mort. Deb., Nos. 1 to 3,000, red. 1909 | 100 | ... | ... | ... | 100 —103 | 100 —103 | 100⅛ | ... |
| 200,000£ | Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000 | 25 | ... | ... | ... | 100 —103% xd | 100 —103% | ... | ... |
| 180,227 | Globe Telegraph and Trust | 10 | 4½% | 5½% | 5½% | 11¼— 11⅝xd | 11¼— 11⅜ | 11½ | 11¼ |
| 180,042 | Do. do. 6 % Pref. | 10 | 6 % | 6 % | ... | 15½— 15⅝xd | 15 — 15½ | 15⅝ | 15 |
| 150,000 | Great Northern Telegraph, of Copenhagen... | 10 | 10 % | 12½% | ... | 32 — 34 | 32 — 34 | 62 | ... |
| 86,300 | Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red. | 100 | ... | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 17,000 | Indo-European Telegraph | 25 | 10 % | 10 % | 10 % | 54 — 58 | 54 — 58 | ... | ... |
| 100,000£ | London Platino-Brazilian Telegraph, 6 % Debs. | 100 | 6 % | ... | ... | 105 —108 | 105 —108 | ... | ... |
| 72,680 | Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 | 1 | ... | ... | ... | ¼— ½ | ¼— ½ | ... | ... |
| 86,492 | Do. do. 5% Pref., Nos. 1 to 86,492 | 1 | 4 % | 4 % | 2½% | ⅝— 1 | ⅝— 1 | ... | ... |
| 490,000 | National Telephone, 1 to 490,000 | 5 | 6 % | 6 % | 5 % | 4⅞— 5⅛ | 4⅞— 5⅛ | 5 | 4⅞ |
| 15,000 | Do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 13 — 15 | 13 — 15 | 14⅛ | 13½ |
| 15,000 | Do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 13 — 15 | 12 — 14 | 13½ | 12 |
| 250,000 | Do. 5 % Non-cum. 3rd Pref., 1 to 250,000 | 5 | 5 % | 5 % | 6 % | 5⅛— 5⅜ | 5⅛— 5⅜ | 5¼ | 5⅛ |
| 2,000,000£ | Do. 3½ % Deb. Stock Red. | Stock | 3½ % | 3½ % | 3½ % | 97 —100 | 97 —100 | 97 | ... |
| 171,504 | Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid | 1 | 5 % | 5 % | 5 % | ⅞— 1 xd | 1/16— 1 1/16 | 1 | ... |
| 100,000£ | Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 | 100 | 4 % | ... | ... | 102 —105 | 102 —105 | ... | ... |
| 11,839 | Reuter's | 8 | 5 % | 5 % | ... | 7 — 8 | 7 — 8 | 7 9/16 | ... |
| 3,381 | Submarine Cables Trust | Cert. | ... | ... | ... | 124 —129 | 124 —129 | 124 | ... |
| 58,000 | United River Plate Telephone | 5 | 5 % | 6 % | 6 % | 4⅜— 5⅛ | 4⅜— 5⅛ | ... | ... |
| 16,639 | Do. do. 5 % Cum. Pref. Nos. 1—16,639 | 5 | ... | ... | ... | 4⅜— 5⅛ | 4⅜— 5⅛ | ... | ... |
| 179,947 | Do. do. 5 % Debs. | Stock | .. | ... | ... | 103 —106 | 103 —106 | ... | ... |
| 200,000£ | West African Telegraph, 5 % Debs. | 100 | % | ... | ... | 97 —100 | 97 —100 | 99 | ... |
| 30,008 | West Coast of America, Nos. 1—30,000 and 53,001—53,008 | 2½ | ... | ... | ... | ½— 1 | ½— 1 | ... | ... |
| 150,000 | Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel. | 100 | ... | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 389,731 | Western and Brazilian Telegraph 4 % Deb. Stock Red. | Stock | ... | ... | ... | 100 —104 | 100 —104 | ... | ... |
| 267,930 | Western Telegraph, Ltd., Nos. 1—207,930 | 10 | 7 % | 7 % | ... | 14½— 15 | 14½— 15 | 14⅞ | 14⅜ |
| 75,000 | Do. do. 5 % Debs. 2nd series, 1906 | 100 | ... | .. | ... | 105 —108 | 105 —108 | 107⅛ | ... |
| 88,321 | West India and Panama Telegraph | 10 | 2½% | 2 % | ... | ⅞— 1⅛ | ⅞— 1⅛ | ... | ... |
| 84,568 | Do. do. do. 6 % Cum. 1st Pref. | 10 | 6 % | ... | ... | 9¼— 9⅜ | 9¼— 9⅜ | 9 5/16 | ... |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. | 10 | 6 % | ... | ... | 7 — 8 | 7 — 8 | ... | ... |
| 80,000£ | Do. do. do. 5 % Debs., Nos. 1 to 1,800 | 100 | 5 % | ... | ... | 104 —107 | 104 —107 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 19,661 | Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761 | 5 | 4 % | 6 % | 6 % | 7 — 8 | 7 — 8 | ... | ... |
| 12,000 | Do. do. 7 % Cum. Pref. | 5 | 7 % | ... | ... | 8⅛— 9⅛ | 8⅛— 9⅛ | ... | ... |
| 50,000 | Charing Cross and Strand Electricity Supply | 5 | 7 % | 8 % | 9 % | 9 — 10 | 8½— 9½ | 9⅜ | 9 1/16 |
| 20,000 | Do. do. do. 4½ % Cum. Pref. | 5 | ... | ... | ... | 5¼— 5⅞ | 5¼— 5⅜ | .. | ... |
| 84,000 | *Chelsea Electricity Supply, Ord., | 5 | 6 % | 6 % | 6 % | 6⅞— 7⅛ | 6⅞— 7⅛ | 6⅞ | .. |
| 150,000 | Do. do. do. % Deb. Stock Red. | Stock | 4½ % | ... | .. | 108 —111 | 108 —111 | 1 9 | .. |
| 60,000 | City of London Electric Lighting, Ord. 40,001—100,000 | 10 | 10 % | 6 % | 4 % | 9½— 10⅛ | 10— 11 | 10⅜ | 10⅛ |
| 40,000 | Do. 6 % Cum. Pref., 1 to 40,000 | 10 | 6 % | 6 % | ... | 12 — 13 | 12 — 13 | 12 13/16 | 12⅜ |
| 400,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | ... | ... | 122 —127 | 122 —127 | 125 | ... |
| 40,000 | County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000 | 10 | nil | nil | 4 % | 9½— 10½ | 9½— 10½ | 10 | 9 1/16 |
| 20,000 | Do. do. do. 6 % Pref., 40,001—60,000 | 10 | 6 % | 6 % | ... | 12 — 13 | 12 — 13 | ... | ... |
| 200,000 | Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. | ... | ... | ... | ... | 110 — 113 | 109 —112 | 110½ | 109⅜ |
| 26,100 | Edmundsons Elec. Corp., Ord. Shares | 5 | 5 % | 7 % | ... | 4½— 5 | 4½— 5 | ... | ... |
| 75,000 | Do. do. 4½ % 1st Mort. Deb. Stock | 100 | ... | ... | ... | 101 —104 | 101 —104 | ... | ... |
| 110,000 | London Electric Supply Corporation, Limited, Ord. | 3 | ... | ... | ... | 1½— 2 | 1½— 2 | ... | ... |
| 49,840 | Do. do. do. 6 % Pref. | 5 | ... | 6 % | ... | 4½— 4⅝ | 4½— 4⅝ | ... | ... |
| 250,000 | Do. do. do. 4% 1st Mt. Db. Stock Rd. | Stock | ... | ... | ... | 100 —102 | 100 —102 | ... | ... |
| 85,000 | Metropolitan Electric Supply, 101 to 62,500 | 10 | 6 % | 5 % | 5 % | 13½— 14½ | 13½— 14½ | 14 | ... |
| 220,000£ | Do. 4½ % First Mortgage Debenture Stock | ... | 4½% | ... | ... | 114 —117 | 114 —117 | ... | ... |
| 220,000 | Do. 3½ % Mort. Deb. Stock Red. | Stock | ... | ... | ... | 96 — 98 | 96 — 98 | ... | ... |
| 6,452 | Notting Hill Electric Lighting | 10 | 6 % | 6 % | 7 % | 15½— 16½ | 15½— 16½ | ... | ... |
| 40,000 | St. James's and Pall Mall Electric Light, Ord. | 5 | 14½% | 14½% | 14½% | 14½— 15½ | 14½— 15½ | 15 3/16 | 1[illegible] |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 8½— 9½ | 8½— 9½ | ... | ... |
| 12,000 | Smithfield Market Elect. Supply, Ord. | 5 | ... | ... | ... | 2 — 2¼ | 2 — 2¼ | ... | ... |
| 50,000 | Do. Do. 4 % Deb. | 100 | ... | ... | ... | 85 — 95 | 85 — 95 | ... | ... |
| 65,000 | South London Electricity Supply, Ord. | 5 | ... | ... | ... | 4 — 4½ | 4 — 4½ | ... | ... |
| 79,900 | Westminster Electric Supply, Ord., 101 to 80,000 | 5 | 12 % | 12 % | 13 % | 14½— 15½ | 14½— 15½ | 16 | 15 3/16 |

* Subject to Founder's Shares.
Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next,

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

| Present Issue. | NAME. | Stock or Share. | Dividends for the last three years. 1897. | 1898. | 1899. | Closing Quotation May 2nd. | Closing Quotation May 9th | Business done week ended May 9th, 1900. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 65,000 | Aluminium shares, Nos. 1—65,000 ... ... ... ... | ‡ 1 | 10 % | 20 % | ... | 2⅜— 3¼ | 2⅜— 3¼ | ... | ... |
| 90,000 | Do. 4½ % 1st Mort. Deb. Stock Red. ... ... | Stock | ... | ... | ... | 96 —101 | 96 —101 | ... | ... |
| 30,000 | British Electric Traction ... ... ... ... ... | 10 | ... | 6 % | ... | 16 — 17 | 15½— 16½ | 16 | 15⅞ |
| 50,000 | Do. do. 6 % Cum. Pref. ... ... ... | 10 | ... | ... | ... | 12⅜— 13¼ | 12 — 13 | 12⅞ | 12½ |
| 200,000 | Do. do. 5 % Perpetual Debenture Stock ... | Stock | ... | ... | ... | 124 —127 | 124 —127 | ... | ... |
| 45,000*l* | †British Electric Works Co., Ord. £1 shares, 50,001—95,000 | ... | ... | ... | ... | ⅞— 1 | ⅞— 1 | ... | ... |
| 50,000 | † Do. do. 6 % Cum. Pref., 1—50,000 ... | ... | ... | ... | ... | 1 3/16— 1 5/16 | 1 3/16— 1 5/16 | ... | ... |
| 500 | † Do. do. 4½ % 1st Mort. Deb. ... ... | 100 | ... | ... | ... | 99 —101 | 99 —101 | ... | ... |
| 40,000 | British Insulated Wire Ord., Nos. 1 to 40,000 ... ... | 5 | 15 % | 15 % | 20 % | 11 — 12 | 11 — 12 | ... | ... |
| 27,500 | Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ... | 5 | ... | ... | ... | 6 — 6½ | 6 — 6½ | ... | ... |
| 90,000 | Brush Elecl. Engng., Ord., 1 to 90,000 ... ... ... | 3 | 3 % | 5 % | ... | 1¾— 2 | 1¾— 2 | 1 15/16 | 1 13/16 |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 6 % | 6 % | ... | 2 — 2¼ | 2 — 2¼ | ... | ... |
| 125,000*l* | Do. do. 4½ % Perp. Deb. Stock ... | Stock | ... | ... | ... | 108 —113 | 108 —113 | ... | ... |
| 50,000 | Do. do. 4½ % 2nd Deb. Stock Red. ... | Stock | ... | ... | ... | 103 —105 | 103 —105 | ... | ... |
| 20,000 | Callender's Cable Construction shares, Nos. 1—20,000 ... | 5 | 12½ % | 15 % | ... | 14½— 15½ | 14½— 15½ | 15¼ | ... |
| 20,000 | Do. do. 5 % Cum. Pref. ... ... ... | 5 | ... | ... | ... | 5½— 6 | 5½— 6 | ... | ... |
| 90,000 | Do. do. 4½ % 1st Mort. Deb. Stock Red. | Stock | ... | ... | ... | 112 —116 | 112 —116 | ... | ... |
| 213,533 | Central London Railway, Ord. Shares ... ... ... | 10 | ... | ... | ... | 10 — 10⅛ | 10 — 10⅛ | 10 5/16 | 10 |
| 61,033 | Do. do. Pref. half-shares ... ... | 5 | ... | ... | ... | 4⅜— 5¼ | 4⅜— 5¼ | 5 | ... |
| 71,447 | Do. do. Def. do. ... ... ... | 5 | ... | ... | ... | 5 — 5¼ | 5 — 5¼ | ... | ... |
| 855,000 | City and South London Railway ... ... ... ... | Stock | 1¾% | 2¼% | 1¾% | 64 — 67 | 61 — 64 | 63 | ... |
| 37,500 | Do. do. Ord. shares, Nos. 22,501 to 60,000 ... | 10 | ... | ... | ... | 6 — 7 xd | 5½— 6½xd | 6 | ... |
| 32,098 | Crompton & Co., Nos. 1 to 32,098 ... ... ... ... | 3 | ... | 6 % | ... | 3½— 4 | 3½— 4 | ... | ... |
| 100,000 | Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red. | ... | ... | ... | ... | 99 102 | 99 —102 | ... | ... |
| 99,261 | Edison & Swan Utd. El. Lgt., "A" shares, £8 pd. 1 to 99,261 | 5 | 6 % | 6 % | ... | 2 — 2¼ | 2 — 2¼ | 2 | ... |
| 17,189 | Do. do. do. "A" Shares, 01—017,189 | 5 | 6 % | 6 % | ... | 3¼— 4¼ | 3¼— 4¼ | 4⅜ | ... |
| 344,023 | Do. do. do. 4 % Deb. Stock Red. ... | 100 | ... | ... | ... | 93 — 95 | 93 — 95 | ... | ... |
| 112,100 | Electric Construction, 1 to 112,100 ... ... ... ... | 2 | 6 % | 6 % | ... | 2⅛— 2⅜ | 2⅛— 2⅜ | 2⅛ | ... |
| 25,000 | Do. do. 7 % Cum. Pref., 1 to 25,000 ... | 2 | 7 % | 7 % | ... | 2⅜— 3¼ | 2⅜— 3¼ | ... | ... |
| 140,300 | Do. do. 4% Perp. 1st Mort. Deb. Stock ... | Stock | ... | ... | ... | 103 —107 | 103 —106 | ... | ... |
| 9,600*l* | Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ... | 10 | 7 % | 7 % | ... | 10 — 11 | 10 — 11 | ... | ... |
| 80,000 | Henley's (W. T.) Telegraph Works, Ord. ... ... ... | 5 | 12 % | 14 % | 15 % | 13½— 14½ | 13½— 14½ | 14¼ | 13¾ |
| 30,000 | Do. do. do. 4½ % Pref. ... ... | 5 | 7 % | 7 % | ... | 5¼— 5⅜ | 5¼— 5⅜ | 5⅜ | ... |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock... | Stock | 4½% | ... | ... | 110 —114 | 110 —114 | ... | ... |
| 50,000 | India-Rubber, Gutta-Percha and Telegraph Works ... | 10 | 10 % | 10 % | ... | 21 — 22 | 21 — 22 | 21 9/16 | 21⅛ |
| 800,000 | Do. do. do. 4 % 1st Mort. Debs. | 100 | ... | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | 3½% | 3½% | 3⅜% | 8⅝— 8⅞ | 8 13/16— 8 15/16 | ... | ... |
| 10,000 | † Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 13 — 13½ | 13½ — 13¾ | ... | ... |
| 37,350 | Telegraph Construction and Maintenance ... ... ... | 12 | 15 % | 15 % | 15 % | 35 — 39 | 35 — 39 | 37½ | 36½ |
| 150,000 | Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ... | 100 | ... | ... | ... | 102 —105 | 102 —105 | ... | ... |
| 20,000 | Telegraph Manufacturing, Ord. Nos. 1 to 20,000 ... | 5 | ... | 8 % | ... | 10 — 11 | 10 — 11 | 10½ | ... |
| 20,000 | Do. do. 5% Cm. Prf. Nos. 1 to 20,000 ... | 5 | ... | ... | ... | 5½— 6 | 5½— 6 | ... | ... |
| 540,000*l* | Waterloo and City Railway, Ord. Stock ... ... ... | 100 | ... | 3 % | 3 % | 100 —103 | 100 —103 | 101 | ... |

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 103—106.
National Electric Free Wiring, 12/6 paid. ⅜—½ xd.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17½—18½.
Do. do. Pref. (£10 pd.), 10¼—10⅝.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅛—8⅛. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 18.

* From Birmingham Share List.

**Bank rate of discount 4 per cent. (January 25th, 1900).**

## MARKET QUOTATIONS, Wednesday, May 9th.

| CHEMICALS, &c. | This week. | Last week. | Inc. or Dec. |
|---|---|---|---|
| a Acid, Hydrochloric .. .. per cwt. | 5/- | 5/- | .. |
| a " Nitric .. .. .. per cwt. | 22/- | 22/- | .. |
| a " Oxalic .. .. .. per cwt. | 32/- | 32/- | .. |
| a " Sulphuric .. .. .. per cwt. | 5/6 | 5/6 | .. |
| a Ammoniac, Sal .. .. .. per cwt. | 40/- | 40/- | .. |
| a Ammonia, Muriate (crystal) .. per ton | £34 | £34 | .. |
| a " " .. .. per ton | £31 | £31 | .. |
| a Bleaching powder .. .. per ton | £7 | £7 | .. |
| a Bisulphide of Carbon .. .. per ton | £15 | £15 | .. |
| a Borax .. .. .. per ton | £16 10 | £16 10 | .. |
| a Benzole (90 %) .. .. .. per gal. | 7/- | 7/- | .. |
| a " (50/90 %) .. .. per gal. | 5/6 | 5/6 | .. |
| a Copper Sulphate .. .. .. per ton | £26 10 | £26 10 | .. |
| a Lead, Nitrate .. .. .. per ton | £25 | £25 | .. |
| a " White Sugar .. .. .. per ton | £31 | £31 | .. |
| a " Peroxide .. .. .. per ton | £27 10 | £27 10 | .. |
| a Methylated Spirit .. .. .. per gal. | 2/9 | 2/9 | .. |
| a Naphtha, Solvent (90 % at 160° C.) .. .. .. .. per gal. | 5/6 | 5/6 | .. |
| a Potash, Bichromate, in casks.. per lb. | 4¼d. | 4¼d. | .. |
| a " Caustic (76/80 %) .. .. per ton | £24 | £24 | .. |
| a " Bisulphate .. .. .. per ton | £35 | £35 | .. |
| a Shellac .. .. .. .. per cwt. | 68/- | 68/- | .. |
| a Sulphate of Magnesia .. .. per ton | £4 10 | £4 10 | .. |
| a Sulphur, Sublimed Flowers .. per ton | £6 | £6 | .. |
| a " Recovered .. .. per ton | £5 10 | £5 10 | .. |
| a " Lump .. .. .. per ton | £5 | £5 | .. |
| a Soda, Caustic (white 70 %) .. per ton | £10 15 | £10 15 | .. |
| a " Crystals .. .. .. per ton | £3 | £3 | .. |
| a " Bichromate, casks .. per lb. | 3½d. | 3½d. | .. |
| **METALS, &c.** | | | |
| Aluminium Wire, in ton lots .. per ton | £294 | £294 | .. |
| b " Sheet, in ton lots.. per ton | £191 | £191 | .. |
| p Babbitt's metal ingots .. .. per ton | £80 to £150 | £80 to £150 | .. |
| c Brass (rolled metal 2" to 12") basis per lb. | 8½d. | 8½d. | .. |
| c " Tube (brazed) .. .. per lb. | 10½d. | 10½d. | .. |
| c " " (solid drawn) .. per lb. | 9d. | 9d. | .. |
| c " Wire, basis .. .. per lb. | 8½d. | 8½d. | .. |
| c Copper Tubes (brazed) .. .. per lb. | 11½d. | 11½d. | .. |
| c " " (solid drawn) .. per lb. | 11½d. | 11½d. | .. |
| g Copper Bars (best selected) .. per ton | £88 | £89 | dec. |

| METALS, &c. (*continued*). | This week. | Last week. | Inc. or Dec. |
|---|---|---|---|
| g Copper Sheet .. .. .. per ton | £8 | £88 to £89 | dec. |
| g " Rod .. .. .. per ton | £88 | £88 to £89 | dec. |
| c " (Electrolytic), Bars .. per ton | £85 | £85 | .. |
| c " " Sheets.. per ton | £94 | £94 | .. |
| c " " Rod .. per ton | £88 | £88 | .. |
| c " " H. C. wire per lb. | 10d. | 10d. | .. |
| f Ebonite Rod .. .. .. per lb. | 3/- | 3/- | .. |
| f " Sheet .. .. .. per lb. | 5/- | 5/- | .. |
| n German Silver Wire .. .. per lb. | 1/6 | 1/6 | .. |
| h Gutta-percha, fine .. .. per lb. | 8/- to 8/6 | 8/- to 8/6 | .. |
| h India-rubber, Para fine .. per lb. | 4/3 | 4/2 to 4/3 | .. |
| i Iron, Charcoal Sheets .. .. per ton | £18 | £18 | .. |
| i " Pig (Cleveland warrants) per ton | 74/9 | 75/1½ | 4½d. dec. |
| i " Forgings, according to size per ton | From £11 | From £11 | .. |
| i " Scrap, heavy .. .. per ton | 70/- to 72/6 | 70/- to 72/6 | .. |
| i " Wire galvanised No. 8 .. per ton | £14 5 | £14 5 | .. |
| g Lead, English Ingot .. .. per ton | £17 2 6 to £17 5 | £17 | inc. |
| g " " Sheet .. .. per ton | £18 10 | £18 10 | .. |
| m Manganin Wire No. 28.. .. per lb. | 8/- | 8/- | .. |
| g Mercury .. .. .. per bottle | £9 10 | £9 10 | .. |
| d Mica (in original cases), small per lb. | 3d. to 9d. | 3d. to 9d. | .. |
| d " " " medium per lb. | 1/9 to 2/9 | 1/9 to 2/9 | .. |
| d " " " large per lb. | 3/3 to 7/3 | 3/3 to 7/3 | .. |
| p Phosphor Bronze, plain castings per lb. | 1/1 to 1/4 | 1/1 to 1/4 | .. |
| p " rolled bars & rods per lb. | 1/1 to 1/4 | 1/1 to 1/4 | .. |
| p " r'l'd str'p & sheet per lb. | From 1/3 | From 1/3 | .. |
| c Platinum .. .. .. per oz. | £3 12 | £3 12 | .. |
| p Silicium Bronze Wire .. .. per lb. | 10½d to 1'- | 10½d. to 1/1 | .. |
| i Steel, Magnet, acc'd'g to desc'p'n p. ton | From £15 to £40 | .. | .. |
| i Steel, Magnet, in bars .. .. | £58 | £58 | .. |
| g Tin, block .. .. .. .. per ton | £140 10s. £141 10s. to | £141 to £142 | 10/- dec. |
| g " foil .. .. .. .. per lb. | 1/9 | 1/9 | .. |
| n " wire Nos. 1 to 16 .. .. per lb. | 1/9 | 1/9 | .. |
| p White Anti-friction Metals— "White Ant" brand .. per ton | £40 to £70 | £40 to £70 | .. |
| j Yarns, Cotton, Single 10lb. bundles pr lb. | 8½d. | 8½d. | .. |
| j " Best Flax, 6 lea. .. per lb. | 6d. | 6d. | .. |
| j " Hemp, 8 ply 10 lbs. .. per lb. | 4½d. | 4½d. | .. |
| j " " Russian, 10 lbs. per lb. | 5½d. | 5½d. | .. |
| j " Jute, 180 lbs. rove .. per ton | £14 10 | £15 | 10/- dec. |
| k Zinc, Sheet (Vielle Montagne bnd.) p.t. | £27 5 nett. | £27 5 nett. | .. |

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

## INSTITUTION OF ELECTRICAL ENGINEERS.

### ON DISTANT ELECTRIC POWER TRANSMISSION.

By Prof. George Forbes, F.R.S., Member.

(*Paper read April 26th*, 1900.)

Your President did me the honour to invite me to read a paper on the subject of the distant electric transmission of power, to which I have devoted much attention during the last 10 years. From the remarks he made at the time, it seemed to me that what he most desired was a description of the works of this character which have been established in different parts of the world, with the object of provoking a discussion, on their various merits and defects, by members of the Institution. I regret that to myself it seems undesirable that anyone should give to the Institution descriptions of works carried out elsewhere if he has not an intimate personal practical knowledge of the works; but, in view of the fact that the discussion of this paper may bring out information from those who have actually had the handling of such works, I have yielded to the President's wish to a certain extent. The first part of the paper is devoted to the description of certain selected transmission plants, each one put up by a different contractor, and each one having some special point of interest. But I must freely confess that the only one of these of which I have that intimate practical knowledge which enables one to judge on the merits or defects of a scheme is the plant at Niagara Falls, the plans for which were prepared by me in 1890 and carried out between that date and 1895, and the actual working of which I have thoroughly investigated up to the summer of 1899, by a study of the journals, log-books, and complaints from consumers about faulty supply. Concerning the other installations, I have had to make use of the printed descriptions appearing in technical and other journals, which are always liable to mislead, especially as to the satisfactory nature of the supposed uninterrupted supply of power.

The second part of the paper deals with some of the problems that face the consulting engineer in his attempts to introduce the highest economy, especially in the transmission lines, as this is the most important part when the distances are great. To these sections of the paper some words have been added to give a general view of the methods in use by different contractors. Hitherto manufacturers and contractors in this country, having few great water powers in Great Britain, have neglected to attempt the supply of suitable machinery for other parts of the world, and run a risk of being passed over entirely in the future as they have been in the past, when tenders for the electric utilisation of water powers are asked for; it is perhaps wrong to say that they have been overlooked, and more just to say that they have refused to undertake such work. I venture to put forward the opinion that this is unwise, and I trust that the immediate progress that we expect in the transmission of power generated in the neighbourhood of coal pits will lead the manufacturers of this country to appreciate the large field that is opened to them abroad for the utilisation of water power.

If this be done I believe that British manufacturers may work upon new and independent lines and that they will have a large outlet in our Colonies and other parts of the world; because out of numerous tenders that have been submitted to me for the transmission of power from waterfalls, none of the foreign firms who have tendered seem to me to have started on the best lines for making such a work successful and absolutely free from interruptions.

If our manufacturers, owing no doubt partly to the fact that their hands are full, have been unwilling to undertake these great works, while foreign firms have been making a splendid start, it must be allowed that the want of progress in our Colonies is also largely due to the timidity of our financial men. It is not in this country that you would have found men with the boldness to risk their capital in transmitting and distributing electricity for power purposes, at a date (1890) when there was only one example of such transmission and distribution, viz, in a small village near the frontier of France and Switzerland. Nor would confidence have been placed by them in an electric transmission by means of alternating current at a date when there was not a single alternating current motor in commercial use, nor in the advantages of lower frequency than any which had been thought of up to that date (1893), when nine-tenths of the members of this Institution who rose to discuss the question condemned a frequency of 25 periods per second as impossible and extravagant.* Our capitalists are too apt to say that such things are too experimental, when any step is taken to improve methods. Yet the capitalists in America who undertook to utilise the Niagara Falls did all these things, made a commercial and engineering success of their works and have been imitated in their methods all over the world.†

Attention must now be drawn to a few of the most interesting cases of using electricity for developing the power of waterfalls.

1.—Of the various plants for transmitting electrical power from waterfalls, one which derives its chief interest from the greater distance to which the energy is transported, is in South California at San Bernandino and Los Angelos, carried out by the General Electric Company, U.S.A.

The water is taken from the streams in the San Bernandino Mountains, and it is carried in canals and tunnels for about 2½ miles. It develops power under the head of over 700 feet, three-phase electric currents are there generated and raised by transformers to a pressure of 33,000 volts, and the current is transmitted over a distance of 80 miles to Los Angelos; 80 per cent. of the water conduit is in tunnel, and of the rest part is open masonry canal and the remainder timber flumes. There are 18 tunnels whose total length is 11,555 feet, the longest being 2,074 feet. There are 2,662 feet of wooden flumes, 167 feet of open masonry canal, 121 feet for a sand-box, and 57 feet of reservoir and forebay at the head of the penstock. The water is taken from a point 3,422 feet above sea-level, the power-house being at a level of 2,670 feet; the slope of the canal is 9·5 feet per mile, leaving an available head of 728 feet at the power house. The streams used are the Santa Anna River and the Bear Creek.

The best description of the civil engineering works is given in the *Engineering News*, New York, March 9th, 1899:—Pelton wheels are used with a nozzle 3⅜ inches in diameter, the wheels are 82 inches in diameter, the regulation is obtained by deflecting the nozzle from its most effective position as the load falls off; four such wheels and generators are in place; the generators deliver current in three phases, and the revolving wheels carry 20 poles, the armature being external, each generator delivers 1,000 H.P., running at 300 revolutions and giving 750 volts. There are 12 transformers in banks of three, on foundations of steel beams and concrete, 30 inches above the floor for the purpose of cooling by a forced air draught. Each transformer raises the pressure to 19,000 volts, making 33,000 volts between wires on the three-phase circuit, the Star connection being used; ⅜ths of an ounce pressure is used with blowers 280 inches in diameter, each requiring 3 H.P. There are two three-wire circuits of No. 1 B. and S. copper wire, and the insulators are placed on the posts at the angles of an equilateral triangle. These insulators, over 6 inches diameter, are bell-shaped, of glazed porcelain, and are bolted to the cross-arm. There are 44 posts to the mile, of white cedar, from 35 to 65 feet high, with 8-inch tops. At Pasadena the voltage is reduced by oil-cooled transformers to 2,200 volts, and the current is used to work a synchronous motor which drives a direct current generator of 525 KW. At Los Angelos there are six 250-KW. transformers reducing the electric pressure to 2,200 volts, and four synchronous motors which drive generators for lighting with continuous current. The information which would be most useful as to the results of working this plant would be about the continuity of working and freedom from interruptions. Such information cannot be obtained accurately except by a prolonged stay at the spot, examination of journals, &c. I am unable to assist in this.

2.—The Snoqualmie Falls have been developed for transmitting power to Seattle and Tacoma, by the Westinghouse Company, U.S.A. The features of greatest interest in this case are the use of the high electric pressure of 30,000 volts, and the use of aluminium for the conductor on the long transmission line. It is impossible for anyone to know what success has attended these novelties, unless he were to examine not only the plant but also the log-book and correspondence. Continuity of performance is of primary importance, but we cannot tell from published accounts whether this has been obtained in the present plant with 30,000 volts. Also we have not any means of knowing what success has attended the use of aluminium wire.

In the development of the Snoqualmie Falls a vertical shaft has been dug 260 feet deep, 10 feet by 25 feet, and the tailrace tunnel is 200 feet. A 7 feet 6 inches steel penstock is in place, and there is room for another. The underground chamber for machinery is 200 feet long, 40 feet wide, and 30 feet high. The penstock is connected at the bottom to a steel receiver 10 feet diameter, 1 inch thick, and 80 feet long horizontally, besides 60 feet length of pipe 7 feet 6 inches diameter.

There are four 1,500-KW. three-phase alternators at a frequency of 45 cycles, and at 1,000 volts. The armature rotates, and is 8 feet diameter, and weighs over 10 tons. Laminated poles are cast into the field frames.

Transformers of 500 KW. with oil insulation are used. Mesh connection (or Δ) for the three phases is used both in primary and secondary.

As to the high pressure transmission line of 80 miles, it is said that 33 tons of aluminium are used for going to Seattle, and 34 tons for going to Tacoma, and that each route has two separate three-phase circuits with 30 inches between wires, that the average span to Seattle is 110 feet, and to Tacoma 150 feet, that Nos. 1 and 2 B. and S. gauge and McIntyre joints are used. There is some discrepancy between the weights of wire used and the power that is said to be transmitted.

The whole of the information here given is taken from technical journals. On this line the electric pressure has sometimes been raised to 40,000 volts, when the phenomena of brush discharge acquire considerable importance. This led Mr. Scott, of Pittsburg, to his interesting experiments on this subject, published by the American Institute of Electrical Engineers.

3.—The Paderna development of the Adda River for supplying electric energy to supplement that in use at Milan, a distance of 33 kilometres, derives its chief special interest electrically from the fact that the energy is generated direct in the alternator at the comparatively high electric pressure of 13,500 volts, the plant having been designed and constructed by Messrs. Brown, Boveri & Co. The only other plant in the world which can be compared in this feature with Paderna is the transmission by the General Electric Company, U.S.A., from Mechanicsville to Schenectady, where both generator and motor are used at 10,000 volts, without the intervention of any transformer.

It would be interesting to discuss the hydraulic part of the work at Paderna, but it is advisable under present conditions to confine remarks as far as possible to some of the electric details. Under the former head it may be said that the minimum flow of the river is taken at 45 tons per second. The dam is 150 metres long. The canal has a slope of 2 per cent., giving a velocity of 2·70 metres a

* The unqualified success of low frequency at Niagara Falls has now, however, converted even former opponents, and this Institution passed a recommendation last year that a frequency of 25 should be a standard for power transmission.

† The only financial group who ever in this country showed such boldness in electric matters was the band of men who realised that Ferranti's brilliant views were right, and who started the London Electric Supply Company.

second when the flow is the maximum allowed for. There are three tunnels, whose total length is 1,686 metres. The open canal is 582 metres. The total fall varies from 28·82 metres to 24·92 metres. The total head available is constantly 22·85 metres, and the suction varies from 6 metres to 2 metres, giving a total power of 13,000 B.H.P. The type of turbines is horizontal axis, double turbine to balance pressures, radial intake and axial outlet. Each double turbine develops 2,160 B H P. at 180 revolutions per minute. A safety valve is provided, but is not required, as it was found, when closing the outlet of a fully loaded turbine in 2 seconds, that the pressure rose only 9 or 10 metres without using the valve.

The dynamos are of the well-known Brown construction. Each is of 2,160 H P. at 180 revolutions, and develops three-phase currents. The armature is fixed and external to the revolving field, which carries 28 poles of steel with laminated horns. The poles are wound with copper strip edge-on. The diameter of the revolving field is 4·1 metres, and that of the whole machine is 5·14 metres. The exciter is in line with the alternator. The frequency is 42 cyles per second. The normal pressure is 13 500 volts at the terminals, and the current should be 64 5 amperes per phase with an induction factor of 1, or 79 amperes with 37° of lag. The efficiency in the former case is 95·1 per cent., in the latter 93 4 per cent. The maximum rise of temperature is 28°C. The machines were deliberately tested at 20,000 to 21,000 volts, and it is said accidentally they were caused to generate current at 30,000 volts without injury.

The line consists of three independent three-wire circuits on two lines of posts 2 metres apart, the distance between any two wires of one circuit being 0 6 metre. The mean distance between the posts of one line is 60 metres. The distance of the high tension transmission is 32,500 metres. The wires are of copper, 9 mm. in diameter, the ohmic loss is 8·1 per cent. and the total loss is 11·7 per cent. for a lag of 37°. A lag of 45° has been observed with a line on short circuit. Wurtz lightning arresters are used at both ends of the line on two of the circuits, and Siemens & Halske horns on the other.

At Milan the pressure is reduced by Ganz transformers of 350-KW., and transmission gives place to distribution.

The above statements of facts are on the authority of E. Vannotti, and were published by *Le Génie Civil*, Paris.

4.—The Rheinfelden plant is here mentioned to allow of discussion on it, and because it is the most successful development of a low fall on the general lines of the Niagara undertaking. It resembles Niagara in using a vertical shaft for each turbine and dynamo. It differs from Niagara in having four different types of dynamos, some giving continuous, and others alternating, current. The turbines are by Escher Wyss, the dynamos by Oerlikon and the Allgemeine Elektricitäts Gesellschaft. The hydraulic works are a model of good work, which I constantly kept before me when planning the work to be undertaken on the Nile Cataracts for the Egyptian Government.

If I were attempting here to give full descriptions, I would devote much space to this excellent installation. Many members of this Institution have, however, inspected the plant, and every engineer who wishes to master this branch of our profession is obliged to read the most admirable description published at Berlin (*Die Kraftübertragungs-Werke Rheinfelden*).

5.—In a paper dealing with transmission schemes which have been carried out, the Genoa continuous-current plant deserves great attention. Here water power is available. The turbines are connected by insulating Raffard couplings to insulated dynamos, which are electrically connected in series. Thus 6,000 to 8,000 volts are delivered at Genoa to work insulated motors, also put in series so as to attain this high electric pressure. In a scheme purely for transmission, and not for distribution, this method of using continuous currents has a great deal of merit, and I believe that we shall all agree that we owe a debt of gratitude to M. Thury for the way in which he has worked out the method at Genoa and elsewhere. A full account of this work has been published, and deserves the closest attention. I could mention cases which have come under my own notice where this system with continuous currents would give better results than the Niagara system with alternating currents.

6.—Having satisfied your President's wish, and put forward as a basis of discussion some of the plants in different parts of the world with the actual working of which I have no practical experience, it is a pleasure now to turn to the work of the Niagara Falls Power Company, concerning the working of which I may be able to supply useful information.

I do not propose here to give a full account of the machinery which we have made use of. It has been well described in the *American Electrician* for January, 1900. It will be better to pass lightly over this part, and devote more attention to the lessons to be learnt from the five years of working.

This plant derives its chief interest from the following facts:—1. It was the first place, except Oyonnax, where a scheme was started on for generating electricity at a waterfall, transmitting it to a distance, and distributing it to consumers for power. 2. It was, and is the largest project of the kind. 3. It was the first case of using the alternating current for power commercially. 4. It was the first case in practice where the commutator for continuous currents was placed at the distant end of the transmission line. 5. It was the first plant to adopt low frequency. 6. All the generators are of the same size and pattern. 7. The Niagara system in its general features has been adopted in almost every subsequent electrical development of water power. The principal feature of the dynamos is that the shaft is vertical, and that the revolving field has its poles external to the armature. In the original drawings and specification issued to manufacturers a circulation of fluid for cooling the armature was provided; the poles were wound with copper strip and mica insulation, and not with wire; and there were no bolts on the outside ring to create undue air friction. I allowed the first three dynamos to be built without these features, but the last seven have had them reintroduced.

The transformers at the power house are the first ever made of great size, and also the first made with great attention paid to cooling by air-blast or oil. Those by the General Electric Company are 1,250 H P. Those by the Westinghouse Company are 2,500 H P.

For the factories within half a mile a subway is used, which I built of concrete.

For the new Carbide works a "Camp" conduit, like our "Doulton" conduit, is used with 10,000 volts.

For the Buffalo transmission bare overhead wire cables are used.

The Aluminium Company had great trouble at first with the rotary transformers used for commutating the current. These were, I believe, the first machines of this class ever ordered for commercial use. The Mathiessen Alkali Works have 11 such machines, with one induction motor for starting the middle one. The others are started from this by temporary belts. They have no hunting, no sparking, and no grooves on the commutators. Hunting is prevented by a modification of the Leblanc cage on the poles. Each machine has six poles, and sparking is prevented by connecting together metallically all the commutator bars which are in the same phase. To prevent grooving of commutators, the shaft is free to move axially, and motion is given to it by an electro-magnet and spring, the current for the electro-magnet being periodically interrupted by clockwork mechanism on the wall.

(*To be continued.*)

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## THE CALCULATION OF DISTRIBUTING SYSTEMS OF ELECTRIC TRACTION UNDER BRITISH CONDITIONS.

By H. M. Sayers, Associate Member.

(*Paper read May 3rd*, 1900.)

The design of electrical distributing systems in this kingdom has been practised hitherto almost exclusively for electric lighting purposes. The short daily duration of the heavy load and small annual load factor obtained in most cases induce economy in capital expenditure, and the current density at times of full load is restricted by considerations of pressure variation, rather than by losses in the conductors. The conditions of working electric tramway systems are so different that calculations of another order come in, and very materially affect the design of the conductors when highest total economy has to be studied. The principal special conditions are as follows:—

1. The high load factor—due to the fact that a large output is called for throughout the whole of the working hours, which are usually from 15 to 18 per day in the United Kingdom. There are daily "peaks," and seasonal peaks, but the hills and valleys are of much less extreme character than those observed on a lighting system.

2. The permissible variation of pressure is much greater. So far as the working of the line is concerned, the only limitation is that sufficient pressure be given at every point to enable the cars to keep schedule time. At the speeds allowed in this country, and with the motors usually fitted, a variation of 10 per cent. of the normal pressure causes no inconvenience.

3. The unsymmetrical arrangement of the two conductors as between the outgoing or insulated positive conductor: and the return earthed negative conductor. In the great majority of cases, the rails forming the negative or return conductors are of such large section that no other conductors are needed on that side of the system whether for economical or pressure regulating purposes—so far as the working of the line is concerned. But for the protection of other property, the extreme potential difference allowed to exist between different points on the rails is limited by the Board of Trade to 7 volts, and the proportion of current allowed to return through the general mass of the earth to an earth plate at the generating station must not exceed 5 per cent. of the average load or 2 amperes per mile of line. Hence, on a tramway or railway using the rails as return conductor, while the positive conductor should be designed with regard to ordinary considerations of economy and efficiency (including the fact that practically the whole of the pressure drop will occur on that side of the system); the negative conductor designed primarily to satisfy mechanical conditions in most cases accidentally happens to afford much better conductivity than the positive conductor, and yet its conductivity has in many cases to be supplemented in order to satisfy the regulations imposed by a benevolent Board of Trade. It will be seen below that the determination of these auxiliary return conductors can be arrived at by calculations similar to those controlling the choice of the positive conductors, but that some of the factors have different values, and their load has to be estimated in a different way.

One effect of these special conditions is that the use of conductors designed for lowest total working cost is practicable in many electric traction systems. The well-known consideration that the total working cost of a conductor during any given time is the sum of two items, one being the value of the power wasted in it, and the other a percentage of its original cost at some annual rate, indicates at once that for a higher load factor a conductor should be worked at a lower rate of loss, or in other words, at a lower current density. To determine the most economical current density in a given case, values are required for the following factors:—1. The money cost of the cable to be employed expressed in terms of the amount of copper in the cable, say the price in pounds of a ton of copper, insulated, sheathed and laid $= p$.

2. The percentage of the cost of the cable which must be annually set aside to provide for interest, maintenance, and depreciation $= B$.

3. The average number of hours per day taken throughout a year that the cable will be under load $= h$.

4. The load factor of the cable during the time it will be under

load. If the load will be steady, the value of this will be unity. If the load will vary in a known way, the load factor will be the mean square value of such variable load referred to a steady load of its maximum value as unity, and can be calculated from a prophetic load diagram, and in the case of such variable load the most economical current density given by the calculations will correspond to the square root of the mean square value of the current.

In what follows, this load factor will be taken as unity.

5. The cost of a Board of Trade unit generated and delivered to the conductor in pence = $n$.

From 3, 4, and 5 the cost per annum of a watt wasted in the conductor can be calculated, or inversely what number $w$ of watts wasted in the cable will cost, say, £1 per annum, and the two quantities representing the total cost per annum reduced to a common measure.

In Perry's "Calculus for Engineers," page 55, the question of economy in electric conductors is used as an example in maxima and minima, and I have found the method there indicated convenient for practical use.

Prof. Perry there shows that the waste in watts or ohmic loss, and the constant loss or interest loss, can both be simply expressed as functions of the resistance of a conductor, assuming a certain current and certain length, and that their value may be written:

$$y = c^2 r + \frac{f^2}{r} + b.$$

Where $c^2 r$ is ohmic loss, $\frac{f^2}{r}$ is the interest item — expressed in watts, and $b$ is a constant which depends upon factors not affected by the size of the cable laid.

In Appendix No. 1 Prof. Perry's expression is worked out at length and the result shown that the most economical current density

$$\frac{c}{a} = \sqrt{\frac{R\ w\ p\ m\ \cdot 045}{100}},$$

where $c$ = amperes, $a$ = cross section of cable in square inches (so that $\frac{c}{a}$ = amperes per square inch) and $m$ = tons of copper in a mile length of 1 square inch section, $R$ = annual rate per cent. for interest, &c.; $w$ = the number of watts wasted continuously during working hours, which will cost £1 in a year's working, and $p$ = the price in pounds of a ton of copper in the form of cable. ·045 is resistance in ohms of a mile of copper of 1 square inch cross-section, the weight $m$ of which is 9·1 tons. In Appendix No. 2 an example is worked out numerically and tables are shown giving values obtained by taking figures within probable practical limits. The method of calculation here used is, of course, perfectly general, and applies equally to low tension, high tension, continuous and alternating currents, however fed to the conductors. The cost per ton of copper in cabled form will, of course, vary widely with the way the cable is to be used, the working pressure, and other conditions; for example, a triple twisted cable for three-phase currents will be much more costly per ton of copper than a concentric cable for continuous currents, working pressure and material being equal. It has also to be carefully noted that the value of the Board of Trade unit to be used is that of the unit delivered to the conductor system under consideration, and if the energy has to be transmitted or transformed before such delivery, the cost of generating the unit has to be "loaded" with the cost of such transmission or transformation, including the interest, maintenance, and depreciation cost of transmitting or transforming system. For example, the most economical density in a low-tension system fed from transformers is lower than in a low-tension system fed direct, assuming that the generating stations in the two cases supply energy at equal costs. It must also be recognised that power wasted (or used) in distribution costs as much as power used in the motors.

For cables of a given construction and for use under given conditions, it will generally be found that the average price per ton of copper taken from makers' prices through such narrow ranges of size as are usually employed on a given system is sufficiently accurate. Where a very wide range of size is called for it may be worth while to calculate separately for the larger and the smaller cables.

The question of systems of laying cables and the cost thereof is not considered here, as the choice of the methods to be used depends much upon various local conditions, and the cost per mile is very little affected by the size of the conductor laid. It may be worth while to suggest, however, that the cost per ton of copper of a cable armoured for laying direct in the ground is higher than that of a similar cable sheathed for drawing into pipes or conduits, and as the allowance for depreciation and maintenance of pipes and conduits is a good deal lower than that for cable, economy may frequently be best studied by the use of a "drawing-in" system. The facilities for renewal and repairs and for replacing cables by others of larger size if required, are advantages not to be lightly ignored, and the conditions on electric traction systems enable these advantages to be utilised to a degree that does not obtain in some other services. The calculation of best sizes for track feeders is exactly that above described, but in most cases a higher value has to be taken for the wasted energy, *i.e.*, $w$ in the equations is smaller. This leads to the use of a lower density in such cables or to a larger provision of copper for the current to be carried. The reason is that in most cases a "negative booster" has to be employed in connection with such a feeder, and the energy wasted has to be loaded with the loss in transforming, and the capital charges on the apparatus. The booster may be considered a part of the feeder, and as its size and the losses in it are proportional to its output, they are properly brought into the calculation by charging a higher price per unit delivered to the cable. Appendix No. 3 gives some examples of such calculations, and is also applicable to trolley feeders in which "boosters" are employed to keep up the voltage at the distant end.

Considering the figures given in the tables, it will be seen that the limiting distance due to loss of pressure in feeders designed on economical principles is reached at from two to three miles from the generating station. The density of the traffic does not affect this limit. The cost of energy does not affect it, and in such a way that the lower this cost, the shorter is the range of economical distribution, because the economical density being higher, the limiting drop of voltage is the sooner reached. But it may be worth while in any particular case to use heavier conductors and so extend the working radius of a station, because the cheaper generation of power at that particular place more than compensates for the increased distribution costs.

It may happen also that the use of heavier mains for the more distant parts of the system may prove to be cheaper than any other means of keeping the pressure up on those parts. It is a useful feature of the methods of calculation herein described that they indicate in a facile way the results of any departure from the theoretically best conductor sections, and so provide at least part of the data for determining the best system to adopt.

When the distribution radii much exceed the distances above named, it will be obvious that the single station supplying direct to the feeder system becomes impracticable, and it is under these circumstances that an engineer is called upon to thoroughly investigate the alternatives, and estimate the total annual cost of working the lines by means of each of such alternatives. Only certain systems in practical use in the United Kingdom can be mentioned. They are —(1) The multiplication of generating stations retaining the direct-current low tension system of generation. (2) The use of battery sub-stations charged from a single generating station. (3) The use of a single generating station, generating polyphase currents at high pressure, and transforming sub-stations placed at suitable points on the line, supplying low tension direct current to the line feeders. The direct current for the lines near the station may or may not be generated by special direct current sets: when it is, separate consideration has to be given to such contiguous area, in calculating conductors and costs.

The second system above-mentioned has but few examples, and reliable data are somewhat difficult to obtain. Its application would seem to be limited to cases where an infrequent service is given on distant lines; hence the feeders having to carry but a small average current, their size may be kept down, and the battery provides for the larger current needed by the cars. It will be obvious that the arrangements require to be carefully thought out in order to ensure the battery being properly charged, and always available during service hours. A very good example is that designed by the late Dr. John Hopkinson for the Leeds Tramways, and described in Prof. Ernest Wilson's "Electrical Traction." It will be found that some complication is involved. Considering the present limited application and the many questions of detail involved in calculating the working cost of such arrangement, the system cannot be discussed now, and is mentioned as a practical means of meeting the demand which may be sometimes made for working a long branch, the traffic on which only calls for a sparse service, or on which the traffic is relatively heavy for only a small portion of the working hours. The discussion will be narrowed down then to a comparison of the first and third alternative systems, involving a statement of the data which affect the choice and the calculations by which the working cost of each may be estimated with an exactness dependent upon the accuracy of the figures adopted. As some of these figures must themselves be estimated, the judgment and experience of the engineer are here very important factors.

It is quite clear that there are two broad questions to be decided; firstly, What will be the total cost of producing a unit at the station or stations? and secondly, What will be the total cost of getting a unit to the car? in each case. The first question involves the charges on the capital cost of the station plant in addition to the working expenses, and the second question involves the efficiency of the distributing system as well as the capital charges upon it, as the cost of delivering a unit includes the energy wasted in its distribution. "Used in distribution" seems a more rational expression than "Wasted in distribution," but the latter phrase is so widely adopted that confusion might result from an attempt to reform.

It is obvious that by the multiplication of directly feeding generating stations *ad lib.* the loss in distribution as above defined may be reduced to any desired extent. On the other hand, with a system involving transformation there is some minimum loss which cannot be reduced, and which corresponds to the attainable efficiency of the transforming devices. Clearly, then, this minimum loss constitutes a handicap upon the multiphase high-tension system which must be overbalanced by other advantages in order to justify its adoption.

The reduction in the cost of generation of energy due to the employment of large units in one large station as against smaller units in a number of stations can only be estimated in advance by a complete study of local conditions guided by experience and judgment. Cases arise, of course, where it is clear that a station at a particular place enjoys such a great advantage as regards cost of fuel, abundant available condensing water, and freedom from neighbours who may object to noise and vibration, that direct and indirect costs must be much lower than in any other available site. The greater economy in staff and in total value of plant and buildings to be obtained by generating at one station instead of several can be estimated very fairly. A more difficult item to estimate is the relative value of the land.

Whilst every case requires special study to determine what advantage in generating costs is attainable by the adoption of the single large station, a study of the distribution costs can be made on general principles, which will indicate what that saving must be in order to give the single station a balance of advantage.

The limit of direct-current supply has been assumed to be the distance at which the drop in the trolley wire is 50 volts, *i.e.*, 10 per cent. of the energy given to the cars. Assuming a uniform distribu-

tion of the cars, this means an average drop of 5 per cent. over the whole system. (Notice that if the system is one radiating from a large town, so that the cars are more dense near its centre, the average drop will be less. It can be calculated as closely as the service can be predicted.) The loss in track feeders will be less; probably 2½ per cent. will cover it in most cases.

This total loss of power in distribution, amounting to 7½ per cent. of that delivered to the cars, can be attained with generating stations spaced from 4 to 6 miles apart, *i.e.*, delivering power, each for a radius of from 2 to 3 miles. As the interest item of distributing cost equals in value that of the loss of power item, it follows that distribution costs in such a system = 15 per cent. of the value of the power delivered to the car, and the total cost of 100 B.T.U. at the cars = that of generating 115 B.T.U. The plant has to be proportioned to produce 107½ per cent. of the energy delivered to the cars, as its normal full load. In a multiphase transforming system, the overall efficiency cannot at present be taken at more than 80 per cent. Mr. Parshall has given figures from Dublin experience showing somewhat lower rates, but 80 per cent. seems attainable. Then the generating stations will have to supply 125 units per 100 units delivered to the cars. The interest and operating costs of the distributing system cannot be calculated so simply in this case as in the former, as moving transforming devices calling for human attention are involved: but if the prices of those devices are known, and a proper rate of interest calculated to cover depreciation, the cost of attendance and sites can be got at pretty closely, and a price worked out per unit delivered to the mains which can be expressed as a percentage rate of loss of the energy delivered. If this is called N, we have the following expression showing at what proportionate cost the high tension station must generate energy to counter-balance the larger distribution losses. $\frac{b}{a} = \frac{115}{125 + N}$, where $b$ equals cost of production at the single high tension and $a$ = cost of production at the multiple low tension stations. Unless $\frac{b}{a} < \frac{115}{125 + N}$, the low tension multiple station system will give the lower working cost. For this calculation to be of any practical value, it is evident that the cost of production must be properly debited with all charges in each case. To make such an estimate for prospective stations with a near approach to accuracy is a task much more difficult than calculating conductors, but an incorrect decision as to the system to be preferred in a given case is not probable if experience and judgment are brought to bear on a careful investigation of the local conditions.

The value, N, above taken includes the interest item on both the high and low tension conductors. This value can be found as in the other case, and will as in that case be equal to the ohmic loss in each; but it must be noted that the cost of a watt is greater in the low tension conductors owing to the transforming loss. The best density in the high tension conductors is found exactly as in the case of direct supply, but the cost per ton of copper will be considerably higher in the case of the three-core high tension cable, and hence the best density will be higher. The interest and operating costs of the transformers must be carefully considered, proper allowance being made for the necessary spare plant and margin of power necessary.

If these costs come to $d$ pence per unit, the condition of advantage for the high tension system is

$$\frac{b + d}{a} < \frac{115}{125 + p},$$

where $p$ is the percentage value of the losses in the high tension conductors. This will usually be small, not over 5 per cent., and taking this value we get

$$\frac{b + d}{a} < \frac{115}{130};$$

so that for equal costs under the two systems

$$b = 885\,a - d;$$

or in words, the cost of generation at the single high tension station must be less than 88½ per cent. of the cost at the low tension stations by the cost per unit of interest, attention, and stores due to the transformers. If $b < \cdot 885\,a - d$, the difference is the saving per unit to be made by the high tension system; if $b > \cdot 885\,a - d$, the difference is the advantage for the low tension system.

*(To be continued.)*

## PROTECTION OF PUBLIC BUILDINGS FROM LIGHTNING.*

Mr. Killingworth Hedges began by a reference to points brought forward in his paper on "The Fire Risks of Electric Lighting," read before the Institute in 1884, and in Colonel Parnell's paper on "The Action of Lightning Strokes in Regard to the Metals and Chimneys of Buildings," read before the Institute in the same year. In the same connection were quoted opinions of Dr. Oliver Lodge, F.R.S., and Prof. Kirchoff, of Berlin. Since the Report of the Lightning-Rod Conference in 1882 there had been no official report on the effect of lightning strokes on buildings protected by conductors, and he hoped his paper would elicit some expression of opinion from architects, who had more opportunities of observing such effects than engineers. Discussing the action of a lightning flash, the author called special attention to its surging effect, which has very destructive tendencies. Lightning conductors, as usually arranged, do not guard at all against what Dr. Lodge termed the "spitting" action. They may serve to discharge or pass off on to the atmosphere the induced electricity from the earth and from the buildings upon it; but as lightning protectors they are so arranged that should they be actually struck by a flash the building would probably be set on fire; there was a chance, too, that a portion of the electric current would be diverted into unearthed metal-work, and prove most destructive in its tortuous course to earth. For the sake of these public buildings, it was necessary to explode the fallacy that a properly constructed lightning-rod never failed. During thunderstorms the atmosphere and all conducting objects in the immediate neighbourhood become charged with electricity at a constantly increasing potential or intensity as we recede from the earth. Even objects directly on the earth, such as railroad tracks, high fences, &c, become charged and will spark. The characteristics of a lightning-flash more particularly concerning the present subject are:—(1) Surging, due to the oscillatory character of the spark, and consisting of a disruptive discharge, sudden and violent, more like the blow of a hammer; (2) Self-induction, a property which gives rise to counter force or choking effect, noticeable in straight wires, but much more pronounced in coils of wire; (3) Side-flash, the result of self-induction. A disruptive discharge will often leave what would ordinarily be called an excellent conductor, and side-flash through the air to other much worse conductors. For instance, the lightning rod may be struck, but instead of following the course provided, a side-flash may select its own path through a wall of brick or stone to a neighbouring gas pipe or bell wire.

The phenomena of surging and self-induction were described by the author and illustrated by diagrams. In dealing with the question whether our public buildings are efficiently protected, the author first reviewed the methods formerly adopted for the protection of St. Paul's Cathedral. The spire of old St. Paul's was partially damaged by lightning three times, and its destruction by fire in 1561 was attributed to the same cause. The author had recently to report on the lightning conductors put up at the Cathedral in 1872. These took the place of the original system erected under the advice of the Royal Society about 144 years ago. They were considered at the time to be the most advanced system of protection. The system was thoroughly overhauled by the author for the purposes of his report, and pronounced to be open to serious criticism. Elements of danger due to inadequate conductors, faulty connections, non-protection, and other causes were found to exist. Of the dome, statues, choir, and towers, none were efficiently protected. The author read extracts from his report, and fully detailed the weak points in the installation. This was an average specimen of the method of protecting public buildings. That more disasters do not happen is due to good luck, and to the fact that the warm air ascending from the numerous chimneys in large towns helps to lessen the violence of thunderstorms; but should a direct flash strike an insufficiently protected edifice, a disaster would occur. Descriptions of Continental and American practice were given by the author, and details of installations on public buildings abroad which he had inspected. The method adopted at the Cathedral of Notre Dame, Paris, the author considered somewhat lacking; that at Cologne Cathedral was far more advanced, the work being carefully executed, and of a design which might be followed with safety. At the Palais de Justice, Brussels, was installed the most recent adaptation of the Melsen system, details of which were given. The author next gave an account of his re-arrangement of conductors for the better protection of St. Paul's. The plan recommended by him, taking into consideration the large amount of copper cable already disposed about the building, was, first, to run three new cables from the metal work of the framework supporting the cross to the roof of the dome (making inter-connection with the iron supports of the structure); there connecting them with the eight existing conductors, and re-uniting them at the base of the dome to the existing system, which is increased by running a new ½-inch seven-ply copper cable on the top of a parapet entirely round the building. From this horizontal conductor, aigrettes, consisting of five pointed copper rods, were teed at intervals by means of special brass boxes tinned inside, into which the cable was placed, the aigrettes first secured by binding and the whole united by running in hard solder. The method of obtaining efficient new earths (a matter of difficulty owing to the nature of the ground), of the process of earth attachment, and the general arrangements were fully detailed and illustrated.

The installation should not be taken as a model one, except, perhaps, with reference to similar ecclesiastical structures, which do not lend themselves very readily to the improved methods of protection, such as the author recommended for all new public buildings. It is almost impossible to draw up a set of rules to be universally applicable; each building should be carefully studied, first, as regards its position with respect to neighbouring structures; secondly, as to the disposition of the metal employed; and, thirdly, with reference to the subsoil and its suitability for earthing the conductors.

Under the head of practical questions, the author then recapitulated a number of rules and principles laid down by Prof. Lodge, supplemented with suggestions of his own, his aim being to elucidate the possibilities of improvements in the erection and testing of lightning conductors. In conclusion, he warned those who had to specify methods of protection to put no faith in the generally received opinion that a certain space contiguous to a lightning-rod is completely protected by it, so that if the rod is raised high enough a building in this protected region is safe. Nothing was more illusory; no space near a rod could be definitely styled an area of protection, for it is possible to receive violent sparks or shocks from the conductor itself without taking into account the phenomena of surging and self-induction.

* Abstract of paper read before the Royal Institute of British Architects by Mr. Killingworth Hedges, M.Inst.C.E., Monday, April 23rd, 1900.

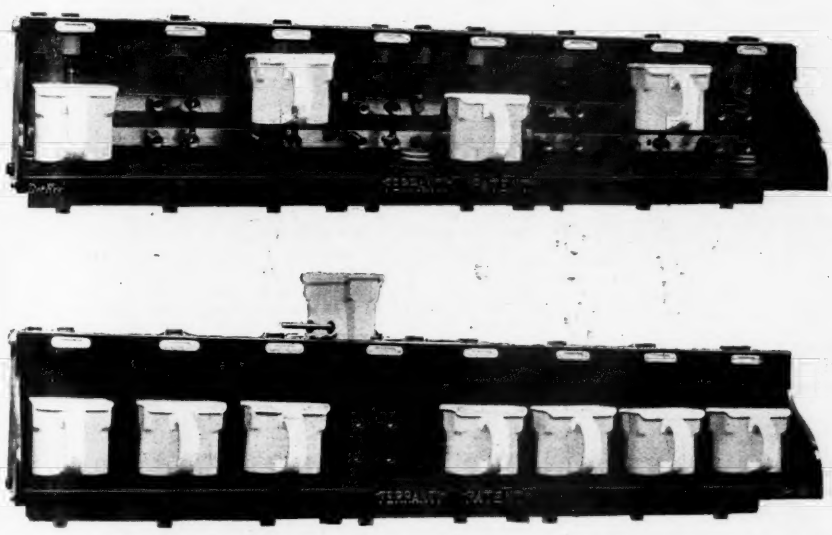
The paper was further illustrated by slides giving views of St. Paul's, Westminster Abbey, Notre Dame and Cologne Cathedrals, and Rockliffe Church, also of lightning discharges showing, first, the popular representation of a flash of lightning, followed by others taken from photographs of actual discharges. These were lent by the Royal Meteorological Society.

On the table were specimens of the fittings designed by the author for St. Paul's Cathedral, exhibited by the manufacturers, the Carboid Company, of Westminster.

## A SIMPLE HIGH TENSION SUB-STATION EQUIPMENT.

On high tension alternating current systems it is common to place a number of transformers in sub-stations or transformer chambers at convenient centres of the district covered by the system. It is customary to lead incoming feeders into these sub-stations in the form of concentric cables with rubber, paper, or other insulating dielectric. Each of these incoming feeders may have to supply current for a number of transformers of the same or different sizes, and for this purpose some distributing device is required by which the current can be led to the primary coils of the transformers.

It is also necessary to have some form of switch gear to cut off the supply to any transformer, either for repairs, removal, or automatically when there is an excess current caused by a faulty transformer or secondary circuit.



Sub-station Gear for Two Feeders and Eight Transformers, with and without Guard Slate.

As this gear is to be left in an isolated place where constant expert supervision is undesirable, it is of vital importance that it should be so constructed as to minimise the chance of a casual operator coming in contact with any of the live parts, and so endangering his life.

In some of the older types of sub-stations the walls and floors are damp, and it is therefore necessary to construct the switching gear in such a way that the insulating properties and durability of any of the parts are not deteriorated by this dampness. Means must also be provided for sealing the insulation at the ends of the cables, with the same object in view.

Simple as the above requirements seem, many complicated devices are in use, and much ingenuity has been displayed in attaining them; but, as is the case with all work of this kind, simplicity in design often leads to the best results. On the other hand, complications are likely to introduce misunderstandings on the part of the operator, and at the same time, by increasing the number of pieces in the appliance, each one of which has its chance of going wrong, they increase the risk of failure.

One type of apparatus in practical use is shown in the accompanying illustrations, which need only a brief description:—

Diagram 1 shows the gear in its simplest form. The inner bar, A, receives the incoming feeder and feeds all the transformers in parallel through the well-known Ferranti oil-break plug fuse; the outer, C, being earthed at the central station, is common to all cables.

Diagram 2 shows the same type of gear, but with two feeders connected to two inner bars respectively. In this case it is possible to plug any number of transformers in parallel on either of the two inner bus bars, and so to either of the two incoming feeder cables. The outer bus bar is also common to all cables.

On alternating current systems where the outer bus bar is not earthed at the central station, it is necessary to have double-pole plug fuses so that the outers can be disconnected from the bars as well as the inners.

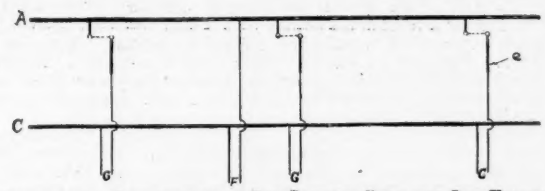



Diagram 1.—Connections of Sub-Station Gear for One Feeder and Three Transformers

In the diagrams the incoming feeder cables, F, are connected by terminals (provided with means for sealing the ends of the cables) to the inner and outer bus bars, A, B, and C, respectively. The cables, G G, leading to the transformers can be either single or concentric, the latter making the neatest connection. The outers of these cables connect direct to the common bar, C, and the inner to the terminal casting, *e*, carried from the top slate by porcelain insulators. This terminal casting is bored at *d* to receive one plug contact of the fuse, the bus bars being provided with corresponding sockets receiving the other plug contact of the fuse. The inner bus bars and all metal work connected thereto are entirely covered in with slate frame work, securely grouted into the sub-station wall. A guard slate covers the front, thus rendering it impossible to get a shock from the bars and connections.

In order to ensure perfect insulation, all metal fittings carrying high tension current are first mounted in porcelain insulators and fixed into the slate framework by a special insulating compound. Thanks to the special construction of the slate work, any moisture running down from the walls will be stopped by the slate before it has an opportunity to get anywhere near these high tension fittings. The plug fuse is made up in a porcelain pot containing oil, which, at the moment of a fuse blowing, puts out the arc, and so automatically and surely disconnects the transformer from the source of supply. The fuse shown is suitable for a working capacity of 100 KW. at 2,000 to 6,000 volts, and only occupies a wall space in width of 9 inches. An ivory name plate is dropped into a metal frame mounted on the top slate over each panel.

This gear, which is made by Messrs. S. Z. de Ferranti, Limited, is working at several places in this country and abroad, including the Victorian Railways (Melbourne), South Shields, and Hammersmith. It is so simple, so safe, so reliable and mechanical, that it forms a very serviceable acquisition to any alternating current supply system.

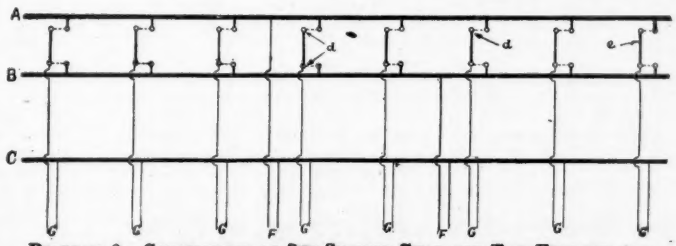



Diagram 2.—Connections of Sub-Station Gear for Two Feeders and Eight Transformers.

## SOME PRACTICAL POINTS IN THE ELECTRO-DEPOSITION OF COPPER.*

By ALFRED F. BAWTREE.

In electro-deposition there is a vast difference between laboratory experiments and commercial work. The chemist uses pure materials, nicely registered current densities and uniform pressures, details

* Paper read before the students of the Finsbury Technical College.

which cannot be attended to in workshop life. A solution three years old is by no means pure, yet one cannot afford to throw away 1,000 gallons of it. A dozen articles in the same vat, all of different shapes and sizes, cannot possibly receive exactly the same current density, or be subject to the same E.M.F. As an illustration of this point an article appeared last year in an electrical paper giving the results of laboratory experiments in copper depositing. The author stated that "a little of the gutta-percha which insulated his wires got into the solution, rendering the deposit brittle and rotten," showing the effect of organic matter upon the solution. Now a certain vat has been depositing on to 24 square feet of gutta-percha moulds for four years, and yields splendid touch copper. So there cannot be much in this discovery.

It is therefore evident that no set of conditions is of practical value that does not permit of very great latitude in every way, but so long as the fundamental principles of deposition are well understood, such a set of conditions can be readily obtained.

The first of these principles is, that the nature of a solid deposit is crystalline, and is therefore in accordance with all the phenomena of crystallisation. Thus the deposit is finer, or, in other words, the crystals are smaller the quicker they are thrown down, unless some other circumstances come in to interfere, as will be presently explained. The slower the deposition, and consequently the larger the crystals, the softer and tougher will be the deposit.

Whatever be the shape of the work, the deposit always tends to go to the edges. In fact, a plate 2 feet square by $\frac{1}{8}$ inch thick at the edges will often be found to be only $\frac{1}{16}$ inch thick in the centre. There actually appears to be a greater current density round the edges—similar to phenomena in statical electricity—for when the current density exceeds a certain amount the copper crystals do not adhere to one another, and a sandy deposit is the result; and this appearance is often seen round the margin of a deposited plate which is quite sound in the centre. Sometimes the concentration of the current at the corners of a piece of work causes the copper to sprout out in coral-like branches, which will grow right to the anode and short circuit the vat unless broken off.

Now as to the smoothness of the back of an electrotype. For copies of engraved plates this is essential, and for all commercial work it is desirable, since roughness is only current and copper expended without adding anything to the strength of the electro. Roughness begins, usually at the first coating of the mould, in the formation of pear-shaped nodules, attached to the plate only by a very fine stem. However thick the work is deposited they never unite to the surrounding copper, but at the least touch come out, drawing in the surface of the work in a little pit. The solution has but little to do with the smoothness of the work. The nodules are due to the crystalline film of copper coming in contact with a microscopic obstruction on the surface of the mould. This sets a crystal up on end, and others growing on it keep their axes parallel to it, and therefore at right angles to the surrounding copper. This accounts for the nodule never growing continuous with the rest of the plate.

Though only a certain E.M.F. can be maintained between the anode and cathode without getting excessive current density, a high pressure in the circuit, cut down by resistance outside the vat by several vats in series, or by a wide gap of solution between anode and cathode tends greatly to smoothen the deposit. To explain this, suppose there is a resisting speck on the plate which one volt extra pressure would drive the current over. If there are 1½ volts between anode and cathode, and only 2 volts in the whole circuit, this extra volt cannot possibly be forthcoming, but with, say, 8 or 10 volts in the circuit, the additional E.M.F. naturally comes, when a point of resistance cuts down the current. Of course, precautions for obtaining smoothness, such as this, cannot be considered where it is required to deposit the maximum weight of metal per horse-power, but where a smooth deposit is the end aimed at, it is an expedient well worth the extra power expended.

Many are the complicated recipes given for solutions for deposition, but, as a matter of fact, almost any solution of copper salts will give a good deposited plate, provided the conducting surface and current density are correct. A sulphate solution need contain nothing but sulphate of copper and sulphuric acid. Anything else added to the bath renders it unstable, and in no way improves the deposit. The most reliable bath, then, is a nearly saturated solution of sulphate of copper, containing 5 per cent. by volume of sulphuric acid.

With regard to the cathode surface, plates of lead or lead and antimony alloy do well where it is simply required to make copper plates. They should be varnished at the back, the edges, and for a narrow margin on the front. Burnished copper plates slightly silvered or oiled, and varnished as already described, are suitable for making electro copper plates for engraving upon, but such copper is far softer than commercial rolled plates.

Non-conducting surfaces prepared either with plumbago, bronze, bronze and silver solution, or phosphorus and silver solutions, as described in any text-book on Electro-Metallurgy, give smooth deposits in proportion, not to their conducting power, but to their smoothness or polish. As an illustration of this if a shallow tray be filled with melted wax, and one half brushed thickly over with plumbago while still slightly warm and sticky, and then when quite hard and cold the other half be highly polished with a thin film of plumbago, the first half will coat long before the other makes a start, but the deposits will resemble a file card as compared to a sheet of paper.

The anodes employed should be made of electrotype copper. They cost very little more than rolled plates, and are cheaper in the end, for they are all copper. The slime that forms on them conducts as well as the plate itself, and therefore deposition can be allowed to proceed for far longer intervals than when copper so impure is used that it insulates itself behind its slime in 12 hours. An electro anode will run 72 hours with but a very slight drop of current. After all that time a swill in water removes the slime without any brushing at all. Anodes should be worked about 1 inch out of the solution and supported by hooks passed through holes in this dry part. They should, if possible, be reversed every day.

Why should a pure copper plate have any slime on it at all? On analysis this slime is found to be chemically pure copper, like the anode. One theory states that the velocity of the molecules of $S\,O_4$ is greater than that of the copper molecules. Hence some of the latter are never taken up but accumulate on the anode. From this it follows that the $S\,O_4$ is always on the increase in the solution, and the $Cu\,S\,O_4$ on the decrease. As a matter of fact, exactly the reverse is the case. In spite of the work and anodes being taken out continually wet with solution and put back wet with water, there is such a rapid absorption of copper by the solution, that a vat run at a rate of 1 ampere per gallon requires diluting with its own volume of water—that is, the replacement of the whole solution by acid and water every year. It is worthy of mention in endeavouring to explain these phenomena that a current density of 25 amperes, the highest generally employed, there is absolutely no sign of gas being evolved from anode or cathode.

## OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Seth Thomas" asks: "Is an electricity supply company liable for damage caused to water pipes by the electrolytic action of return currents?"

*** Seeing that electrical undertakers are usually bound by their provisional order to insulate all mains laid by them in contact with or near to any gas pipe, and are under a penalty for neglecting to do so, it would seem to be clear that they are liable for any damage caused by bad insulation. We presume that the electrolytic action referred to by "Seth Thomas" could not take place unless the insulation is defective. By Clause 16 of the provisional order which is generally used in the London area, electrical undertakers must make full compensation to all owners affected by their workings for any loss, damage, penalty or costs which they may incur by reason thereof; and by Clause 75 of the same order, the undertakers are made liable for all accidents, damages, and injuries happening through their acts or default, or the act or default of any of their servants.

"Inquirer" asks:—"1. Can a corporation object to their plant being used by the consumer only in the event of a breakdown of his own lighting or power installation? 2. Could the corporation charge a higher price than that charged to ordinary consumers for current supplied under such circumstances?"

*** With regard to the first question addressed to us by "Inquirer," a careful study of the Electric Lighting Acts and statutory orders thereunder fails to disclose any provision whereby power is conferred upon undertakers to compel a consumer to take an unintermittent supply. Moreover, it is provided by Section 18 of the Electric Lighting Act, 1882 (45 and 46 V. Cap. 56) that undertakers shall not be entitled to prescribe any special form of lamp, &c., to be used by any company or person, or in any way to control or interfere with the manner in which electricity supplied by them under that Act, and any license, order, or special Act, is used. It should be remarked, however, that this section prohibits a consumer from using his supply in such a way as to interfere with the supply to other consumers, but the demand for an occasional supply could hardly be brought within the mischief, to the suppression of which this part of the section applies. For these reasons we are of opinion that, assuming the consumer uses the minimum amount of energy in the course of the year, or, at any rate, pays for the minimum amount which he undertook to purchase by his agreement with the company, he may avail himself of the supply of energy as little as he chooses.

2. With regard to "Inquirer's" second interrogatory, it is clear from the Electric Lighting Acts that no preference can be given to any particular class of consumers, nor can the company demand an increased price from a consumer who makes use of their supply in a manner best suited to his needs.

We have said that this point is clear from a consideration of the Electric Lighting Acts—but it is just possible that the license order, or special Act authorising the company to supply energy in the district in which "Inquirer" appears to be interested, contains a special clause giving preference to some particular class of customers.

For a further consideration of these interesting points, we would refer "Inquirer" to an article in the Electrical Review for December 8th, 1899, p. 910.

**Society of Model Engineers.**—A meeting was held on Tuesday, May 1st, at the Memorial Hall, Farringdon Street, E.C. Mr. W. H. Dearden read a paper on "Tools and Toolmaking," his remarks having special reference to the construction of his gas engine, which recently gained the society's gold medal. After the paper, trials of modern steam and electric locomotives took place.

* Paper read before the students of the Finsbury Technical College.



## THE APPLICATION OF ELECTRIC TRACTION TO EXISTING RAILWAYS.

By Ed. C. de SEGUNDO, Assoc.M.Inst.C.E.

The experiments now being carried out by the District Railway upon the application of electric traction to trains capable of being hauled by steam locomotives over the same rails are of no little interest, as the successful issue of such experiments will have some considerable influence upon the general question of driving trains by electricity along existing railroads in this country. Unforeseen contingencies are apt to work havoc with engineers' estimates, more especially if the engineer is tied down to existing conditions, as would be the case in adapting the existing underground railways for electric traction, and the hesitation of the directors to take the plunge can be understood. There is no doubt, however, that electric traction will be employed on a portion of the District Railway system, and there is no reason why the result should not be satisfactory commercially.

Electric traction has passed the experimental stage, and the electrical engineer is enabled to calculate with accuracy what the cost of operating a length of line by electricity would be. The idea of the London and North-Western Railway, for instance, being operated electrically is of so revolutionary a character, that its materialisation can only be looked for in the dim and distant future; not because of its physical impossibility, but because of the hopelessness of reconciling the conflicting interests which would arise. Still, the operation of such a railroad by electricity is not more startling, relatively to our times, than is its existence compared with the transport conditions which obtained a hundred years ago, and, having regard to the large number of big cities through which such a railway runs, and to the fact that every city and town of importance is being rapidly equipped with central electric generating plant, the problem of railway electric supply may not be so overwhelming a one as at first sight would appear to be the case.

The electrical operation of main lines may, however, be left out of consideration at the moment, since a more lucrative and appropriate field for technical enterprise in the immediate future is offered by the suburban traffic, which, in towns of large size, is growing by leaps and bounds. In America, the wonderful development of the electric tramway has to some extent entered this field in competition with steam railways. During a recent visit of the author to America, he was told by a prominent official of one of the leading railways that the competition of the trolley car for suburban passenger traffic was beginning to be appreciably felt by the railway in question, and that at the moment he was unable to suggest any way whereby the railway could counteract it. In America, especially in New York, and cities of a similar character, the public appreciation of rapid transit grows year by year, and it is an axiom that if a man has to go to business at all, it is impossible for him to be conveyed there too quickly. In this connection the trolley car can certainly give the railway points. A man living some miles from his business in New York can, in many instances, mount on an electric tram, which may pass the door or the end of the street in which he lives, and he is carried rapidly to the centre of the business part of the town; but if he should elect to come into town by train, he must first walk to the nearest station, carefully timing his arrival so as to catch a train; he arrives at a terminus in the city which may be miles away from the business quarter, and he has to begin another journey. Perhaps the greatest disadvantage offered by the steam railway is the infrequency of the service as compared with the electric car. The foregoing remarks apply peculiarly to New York city, but on broad principles they apply to London and to all large and growing cities, as those who have lived in the suburbs of London know full well.

Metropolitan railways are the necessary ramifications of a main line railway, and should really form part of the same system. The Metropolitan and District Railway Companies have thrown out feelers to outlying districts of London with conspicuous success, but it is clear that a steam locomotive is not a suitable motor for underground traction, and there is nothing but the question of capital outlay to prevent our underground roads being worked electrically.

It is now possible to travel from New York city to Boston entirely by trolley car. It is not suggested that the service of electric cars is such as to warrant anything like a comparison of this method of reaching Boston from New York with that of the steam railway, either in point of time or comfort. The electric tramway was not originally intended to connect the two cities, nor was any idea of competing with the railway present in the minds of those who projected the tramway, but the extensions of various local tramways have been such as to complete the connection between these cities situated 180 miles apart. This fact is only mentioned as indicating that in a densely populated part of the country, the development of other industries in which electric power enters, can be counted upon with some degree of probability to afford facilities for an extended system of electric traction without involving the immense capital outlay that would be entailed by the erection and maintenance of electric generating stations solely for the purposes of the railway at the necessary intervals along the line.

To compete with the steam railway, an electric railway must run at the same or at a higher speed with a more frequent train service, at the same cost per mile. To place the success of the competition beyond a doubt, the cost of transport must be less on the electric road as compared with the steam railway. Anyone who has watched the development of the experiment by railway companies of increasing transport facilities and reducing the fares, will entertain no doubt, whatever as to the result. A practical difficulty, however, stands in the way of any such competition with existing steam roads, at least, in England, namely, the improbability of obtaining the necessary Parliamentary powers. Any attempt to promote a Bill in Parliament for the purpose of building a steam railway in direct competition with any of our existing roads would be difficult enough, but to try to obtain powers for an electric railroad for the same purpose would be hopeless for reasons which are sufficiently obvious to those connected with this department of engineering.

It would appear that the manner in which suburban electric railways are most likely to come into existence without involving an almost impossible financial burden to start with, is by the equipment of a portion of the line for electric traction by the railway company itself. It has been suggested as long ago as in 1895 by a railway authority that a railway possessing a road with four lines should adapt the two lines used for local traffic, for electric traction, and also run its freight trains over the electric road; the objection to this is that owing to the ever growing need of a fast train service to the outlying towns near our great city the electric local trains would have to run at speeds equal to that of express main line trains, and this would seriously disorganise freight traffic. Leaving such a question as the disposal of freight traffic on one side for the moment, it will be of interest to consider the main points that would have to be taken into account by a railway company which contemplated the introduction of a fast and frequent service between the terminus in the city and towns within, say, 20 miles.

The electrically-driven trains would have to run upon the existing roads, the service would have to be regulated by and worked under exactly the same rules as the railway, and the whole equipment as to build of carriages, method of connection, system of brake-power, and so forth, would need to conform with the Board of Trade requirements and with all laws relating to steam railway trains absolutely. In these circumstances, the methods by which electric traction can be introduced on an existing railway—speaking on general principles—narrow down to two, namely, the building of electric locomotives of the power and tractive force required, or, as an alternative, the conversion of some of the passenger coaches into motor cars capable of hauling others. Perhaps the electric locomotive will appeal to the general manager of a railway as being more suited to take the place of the steam locomotive than the motor carriage, because it can do the work of the steam locomotive in every respect, and no change being made in the design of passenger coach, it would be perfectly easy to electrically drive a train a certain distance, and then attach a locomotive for steam haulage to some further point—a condition of things that would frequently obtain in the operation of the road as a whole. Moreover, the experience of the electric roads now

well as the plate itself, and therefore deposition can be allowed to proceed for far longer intervals than when copper so impure is used that it insulates itself behind its slime in 12 hours. An electro

engine, which recently gained the society's gold medal. After the paper, trials of modern steam and electric locomotives took place.



operated in this country tend to show that there is not much to choose between the electrical locomotive and the motor carriage as far as economy in working is concerned, and the weight per passenger seating capacity works out to very nearly the same on the City and South London, which is worked by electric locomotives, and the Waterloo and City, which is operated on the motor carriage principle.

On the other hand, the motor carriage principle is, perhaps, as regards first cost, the cheaper method in which a steam railway can be converted into an electrical one, and for many conditions of suburban traffic requirements within a distance of 20 miles the motor carriage would no doubt prove the least troublesome to operate. A feature in the conditions applying to London is, that owing to the network of lines encountered upon approaching any of the London terminuses, it seems hardly practicable for any underground or overhead system of conductors to be erected which would not cause great inconvenience to the working of the railway generally, and it would appear that in most cases London might have to be entered underground. This would be a most serious matter, not only on account of the expense, but also on account of the influence it would have upon the type and design of motor to be used. The experience gained by the building and operation of the Waterloo and City Railway shows that if more room could be allowed in the tunnels the execution of the work would be enormously facilitated, but owing to the heavy expense of construction, the size of the tunnel is practically determined by the smallest possible space into which the motor truck can be compressed, and while this is not an absolutely prohibitory condition in the case of a railway like the Waterloo and City, where a comparatively high fare can be charged, it would most seriously interfere with the success of the working of a suburban electric line, where very low fares would have to be charged, and a high speed maintained.

*(To be continued.)*

## THE PROTECTION OF INSULATED WIRES FOR ELECTRIC LIGHT AND POWER INSIDE BUILDINGS.

By SYDNEY F. WALKER.

(*Concluded from page* 767.)

In dry buildings, however, which are constantly warmed by heating apparatus in cold weather, very fair results have been obtained by well drying the casing, and painting with successive coats of shellac varnish, allowing each coat to dry well before putting on the next. Shellac has a very high specific resistance, and in this manner a skin of the substance is formed between the insulated wire and the moisture in the casing, which affords additional resistance to the leakage current, and to the general deterioration. With wood casing, also, it is difficult to arrange satisfactorily for wires of opposite sign crossing each other, without either making an ugly bulge in the casing, or offering a dangerous opening for a possible spark.

Casing may, and has been, sunk in channels in the plaster and brickwork, the face board being covered with the ordinary paper, or painted like the remainder of the walls. This is much better than placing it on the surface, but it is often expensive, and nearly always troublesome to arrange. And, after all, wood casing at its best is but a poor makeshift. Householders and others put up with it because they are told that it is necessary.

Further, wood casing, even when well shellacked, is practically useless, after a certain time, if fixed on a damp wall. The shellac is gradually displaced by the wet, and then the process of deterioration of the rubber goes on very rapidly; all the more so from the fact that the wires are usually fixed tightly in their grooves, and that as the wood swells in presence of the moisture, they become more and more squeezed, the moisture following as the squeezing proceeds.

Failing wood casing, then we have the following possible solutions of the problem:—

1. Vulcanised rubber-covered wires, further protected with jute or tape, and laid in channels cut in the plaster.
2. Vulcanised rubber-covered wires, drawn into lead tubes, and these laid in channels cut in the plaster.
3. One of the forms of paper, or fibre insulated wires, in lead tube, these laid in channels cut in the plaster.
4. Vulcanised rubber without lead tube, or one of the paper, or fibre insulation wires, laid in iron pipe, either glass lined or without.

In considering any problem in engineering, it is necessary for success to consider the worst case, the heaviest strain the apparatus will have to stand; and in this case it will be that of the outer wall of a house, which is often very wet during the winter rains, or when snow has collected on the roof and water is trickling from it at every thaw.

In these cases the inside of the walls are also always very damp during the wet season, and the plaster is more or less impregnated with moisture, so that the wires which are placed on those walls will be—during the major portion of the wet season—virtually embedded in a wet sponge.

The evil will be also seriously increased if, as often happens, the walls are exposed to a hot sun during the summer, and when that season is also fairly dry. The walls dry, and the plaster often cracks, leaving fissures for the ingress of the rains of the next wet season. Under these circumstances, vulcanised rubber-covered wires, even when overlaid with jute, will not stand for long unless both rubber and jute are made of such a thickness as to render the cost prohibitive, and the channels in the plaster very large.

Vulcanised rubber-covered wires laid in thin steel tubes made of sheets rolled up, and with the longitudinal joints more or less open, would be subject to very nearly the same influences as the wires laid in the plaster. The wires would not be clasped by a wet sponge, as when in the plaster, but the tubes would form channels for distributing any water, which penetrated anywhere, impartially over the whole system.

Further, the thin tubes would quickly oxidise and become networks in place of tubes, the varnish only delaying the process for a short time.

It must be remembered that, in the plaster of a damp wall, such as is specified above, two agents are present, lime and water, both of which are fatal to vulcanised rubber, and to thin iron or steel pipes, in a certain time, depending inversely on the thickness of the rubber or the pipe.

Vulcanised rubber-covered wires, draw into lead tubes, the whole laid in channels in the plaster, offer probably one of the most certain solutions of the problem, provided that the wires be first well covered with vulcanised rubber and braided, just as if they were to be in casing, and that the lead tube is not squeezed down too tightly on the rubber in the process of drawing the tube down, after the covered wire is inside.

The writer has a very strong objection to placing any conductor outside of the insulating material, because of the danger that the insulator may be damaged in the process of putting on the outer conductor; but in this, as in so many other matters, increased care, and the general advance in the processes of manufacture, have made practicable a great many things that were not so a few years since.

Lead, as is well known, has a very low affinity for oxygen, nor is there any tendency to chemical action between lead and lime, such as there is between the resinous gums of which rubber is composed, and lime. Hence the life of the lead cable, even upon a very damp wall, should be a long one, and in the event of a crack or puncture in the tube, no serious consequences should follow, as the quantity of moisture admitted would be very small. For additional protection, the lead-covered vulcanised wire may be run inside iron pipes if desired, but it appears to the writer to be unnecessary, and, besides adding to the cost, it also adds to the size of the channels in the walls.

The twin form of the paper or fibre insulated wires, overlaid with lead tube, and run in channels in the plaster, is probably the neatest, quickest, and cheapest form of wiring for the inside of buildings. The one objection is, of course, the possibility of a puncture or a crack in the lead tube causing the early breakdown of the insulation.

But again, the development of manufacturing processes, by increasing the flexibility of the cable in some of the later

processes, has very much reduced the possibility of a mischance of this kind; added to which, plasterers are now much more careful than they were 20 years ago, and their additional care is reinforced by the fact that the twin lead-covered wire is very much like the compo. pipe used so generally in gas fitting, and which the plasterer has learned to respect by this time; so that the danger that was so strongly in evidence in the early days of wiring for electric bells, of damage from the plasterer's tool, need not be feared now.

To make sure, the wires can be enclosed in iron pipes, but it hardly appears to be necessary, except in special cases, as the details of the connections between the lead-covered cables and switches, ceiling roses, &c., appear to have been very carefully worked out, and the use of iron pipes, whether glass lined or not, necessitate the use of their own special joint boxes, &c.

Vulcanised rubber-covered wire, or any of the paper or fibre-covered wires run inside glass-lined tube, the rubber-covered wire not being drawn into lead tubes, appears to the writer to be a very efficient arrangement, both electrically and mechanically, but it has the great objection that the glass-lined piping adds very considerably to the cost of wiring, without materially increasing the safety.

The one great feature which it is supposed to possess—freedom from the possibility of transmitting heat to surrounding objects—it is very doubtful, in the writer's opinion, if it does possess to an appreciable extent above its rivals, when properly laid and properly fused, as glass will melt like anything else in the "arc." However, there is one test which never fails in all engineering work, and from which there is no appeal, viz., actual continued use. Vulcanised rubber, either in casing or in plain iron pipes, has failed in the presence of damp.

Lead-covered paper and pipe-insulated wires are on their trial, and appear to be standing it well, with improved manufacture. Vulcanised rubber-covered wires in lead tubes or in glass-lined iron pipes are certain, unless carelessly put in.

## CURRENT SPECIFICATIONS.

### VIII.—HEYWOOD ELECTRIC LIGHTING.

SUMMARY.

*Scope of Tender.*—Complete electric lighting scheme for Heywood Corporation.

*Size and Type of Boilers.*—Two to be supplied, Lancashire type, each 22 feet long by 6 feet 6 inches diameter, capable of evaporating 3,000 lbs. of water per hour at 140 lbs. square inch working pressure with natural draught.

*Fuel Economiser.*—96-tube fuel economiser of Green's, or other approved type to be supplied.

*System of Supply.*—Three-wire direct current with accumulators. Voltage between outers 440 volts, between middle wire and either of outers, 220 volts.

*Number of Generating Units.*—Two steam dynamos.

*Type of Engines.*—Vertical compound enclosed type, Willans, Belliss, or other approved make.

*Speed Specified.*—Not to exceed 500 revolutions per minute.

*Output of Engines.*—75 B H P. at normal speed, working non-condensing with 120 lbs. square inch steam pressure.

*Output of Dynamos.*—Normal output 115 amperes × 440 volts = 50·6 KW. As shunt machines to work up to 520 volts with a 5 per cent. increase in engine speed, and as compound-wound machines for traction purposes to work up to 550 volts. Maximum output = 115 amperes × 550 volts = 63·25 KW.

*Travelling Crane.*—An 8-ton travelling crane, suitable for 30 feet span to be supplied.

*Capacity of Cells.*—230 cells, capacity of each to be 50 amperes at a six-hour, 110 amperes at a two-hour, or 180 amperes at a one-hour discharge rate. Terminal voltage of each cell at end of any of above discharges not to fall below 1·87 volts.

*Insulation of Mains.*—To be either vulcanised rubber, vulcanised bitumen, or impregnated paper. If paper insulated, to be externally sheathed with lead.

*Method of Laying.*—Cables to be laid in solid bitumen in wooden troughs.

*Specified Date of Completion.*—Six months from date of order.

*Penalty for Late Completion.*—£5 per day.

*Stipulations as to Wages Paid to Workmen.*—To be not less than standard local wages, as agreed upon between the Masters' Association and Trade Union for each branch of trade.

*Stipulations as to Removal of Foreman.*—Satisfactory.

*Arbitration.*—Unsatisfactory, see comments below.

*Date for Receipt of Tenders.*—May 14th, 1900.

This specification has been prepared by Mr. W. P. Adams, and is principally noteworthy for the small size of the generating units, two 50-KW. steam dynamos being deemed sufficient for a commencement.

It will be noticed that tenders will only be considered for complete schemes, but that alternative offers for different combinations of plant may be submitted if desired.

The steam dynamos are to be suitable for both lighting and traction (though no provision is made on the switchboard for tramway working), and it is rapidly becoming a feature of British practice to thus require the dynamos to be 20 per cent. larger than necessary for lighting purposes, to permit of their employment if found necessary thereafter for traction work.

There are a few points in the general conditions which, in their present form, are not likely to be acceptable to manufacturers. One referring to contract drawings is of a novel character. It states:—

> **Separate complete working drawings in duplicate shall be submitted by the contractor to the engineer within one month of the acceptance of his tender, as follows:—**
>
> **1. A general arrangement of all the plant, pipes and fittings included in this specification.**
>
> **2. Detailed foundation plans of each piece of the plant where foundations are required.**
>
> **3. A large scale drawing of the switchboard and connections.**
>
> **During the progress of the work such other detailed drawing as the engineer may require shall be submitted. No work shall be proceeded with until the drawings are signed by both engineer and contractor.**
>
> **Such drawings after signature shall be accepted as the working drawings of the contract, and shall be strictly adhered to unless any departure therefrom shall be authorised by the engineer in writing.**
>
> ***The sum of £50 shall be deposited with the Corporation at the time of the signing of the contract, which shall be absolutely forfeited if the drawings are not delivered within the time mentioned.***

The wording of this clause is definite, and does not appear to contemplate the possibility that causes quite out of the contractor's control may delay the completion of these drawings. It seems to us that this is vexatious and unnecessary, and as such ought to be objected to by tenderers.

The required time of completion is six months from date of order, but

> **In the event of the contractor being instructed during the execution of the contract to carry out additional work of such magnitude as will warrant, in the opinion of the engineer, an extension of the time of completion, *an extension may be given such as the engineer considers necessary under the circumstances.* Any extensions granted must be officially sanctioned in writing by the engineer, and will be given without prejudice to the validity of the contract.**

Seeing it is expressly stated that a penalty of £5 per day "*will be rigidly enforced*," it would have been fairer to have stated that the engineer *should* grant under such circumstances a reasonable extension of time.

The following clause as to the supply of foreign-made goods under the contract seems to be fair and reasonable:—

> ***If it is proposed to supply goods other than of British manufacture, this must be distinctly stated at the time of tendering, and, if desired, particulars shall be furnished as to the tenderer's reason for desiring to supply such goods in preference to British-made goods.***

This stipulation might with advantage be inserted in all contracts made by British public bodies; it would prevent a great deal of misunderstanding, and clear the air of many imputations of favouritism for foreign goods made against British municipal authorities.

While it is right for the engineer to have power to reject defective plant, the following penalty, if suitable new plant is not supplied *within one month*, is to say the least drastic:—

> **Should any of the plant fail to comply with the conditions specified, or should the alterations to the plant, necessitated by failure to pass the tests, be unduly delayed, *the engineer may*, after seven**

days' notice in writing, *entirely reject such plant*, and *the contractor shall replace it within one month with plant strictly in accordance with the specification*. Should the contractor fail to do so, the engineer shall have the option of allowing the contractor a further period, or of buying other plant in lieu thereof. In the latter event, no money shall be payable to the contractor on account of such plant, and the Corporation may deduct from any sums payable to the contractor the difference between the contract price of such plant and the price paid by the Corporation.

We have again to complain of restrictions placed upon the operation of the arbitration clause. Compare the following clauses and see if the latter does not nullify to a large extent the benefits secured to the contractor by the former. The arbitration clause reads thus :—

In case any dispute or difference whatsoever shall at any time or times hereafter arise or exist between the contractor and the Corporation touching their respective rights or obligations under the said contract, or the fulfilment or non-fulfilment thereof or incident thereto, *other than such matters as are hereinbefore specifically directed, to be referred to or decided by the engineer as mentioned*, such dispute or difference shall from time to time at the instance or request of either party, be submitted to and decided by the arbitration of two arbitrators, one to be nominated by the contractor and the other by the Corporation, and the proceedings under and consequent upon the said last mentioned reference shall be conducted, and any award or awards to be made thereunder shall be subject to and be governed, conducted, and affected by all the incidents, consequences, and effects of a reference to two arbitrators under the provisions of the Arbitration Act, 1889.

While the limitations referred to are contained in the following paragraph :—

All works in connection with this contract shall be executed in accordance with the wishes of and to the entire satisfaction of the engineer whose instructions on all points in connection therewith shall be complied with, whether given personally or through his representative. *If at any time a disagreement shall arise as to the interpretation or accuracy of the specification or drawings, the points involved shall be decided by the engineer, whose decision shall be final.*

## IX.—KING'S LYNN EXTENSION PLANT.

### Summary.

*System.*—Three-wire direct current, with a voltage of 460 volts across outer conductors.

*Plant Required.*—One 120-KW. steam dynamo, one 200-KW. steam dynamo.

*Type of Engines.*—To be of inverted vertical compound enclosed type.

*Output of Engines.*—To develop 175 and 280 B.H.P. respectively at normal speed with 150 lbs. square inch pressure, working non-condensing.

*Speed of Combinations.*—Left to tenderer's option.

*Output of Dynamos.*—To be shunt wound, and capable of developing rated output at any voltage between 410 and 500 volts at normal speed.

*Steam Consumption Guarantees.*—Guaranteed commercial efficiencies at full, three-quarter, and half-load, and steam consumption per kilowatt-hour, when working both condensing and non-condensing are to be stated in the tender.

*Cell Charging Motor Booster.*—A 5-KW. motor booster for cell charging is also to be supplied.

*Specified Date of Completion.*—One set in *6 months*, the other in *12 months* from date of order.

*Bonus for Early Delivery.*—*£50* if first set is ready for running before the period of *six months* mentioned above.

*Penalty for Late Delivery.*—*One per cent.* per week of contract sum.

*Stipulations as to Wages paid to Workmen.*—None.

*Stipulations as to Removal of Foreman.*—Satisfactory.

*Arbitration.*—No provision for this.

*Date for sending in Tenders.*—May 17th, 1900.

We commented, a few weeks ago, upon the rival reports as to the character of the future developments of the King's Lynn undertaking, presented to the Town Council by Prof. H. Robinson, the consulting engineer for the original scheme, and Mr. Pilling, the resident electrical engineer.

The proposals of Mr. Pilling have been accepted, and in future steam-driven sets will be installed. So far as the technical portion of this specification is concerned, there is little to criticise ; the required results are clearly stated and a free hand is left to the contractor. The same, however, cannot be said for the general conditions. Clause 20 should be objected to *in toto*. We have not a mere limitation of the arbitration clause, but its elimination altogether, and in its place a distinct intimation that the decision of the engineer shall be binding upon the contractor without right of appeal. The clause reads :—

In case of any doubts, disputes, or differences arising or happening, touching, or concerning the said works, or in anywise relating to the construction or meaning of these conditions or the specification or any part or parts thereof respectively, *such doubts, disputes, or differences shall from time to time be referred to and left to the sole and absolute arbitration and decision of the engineer, and his decision shall be final and binding on all parties, and the directions, decisions, admeasurements, valuations, certificates, orders, and awards of the engineer shall be final and binding on the contractor and corporation respectively, and shall not be set aside or attempted to be set aside on any ground whatever.*

This stipulation affects more or less the other clauses in the general conditions. Thus the one dealing with alterations in the contract during the progress of the work contains the following sentence :—

The Corporation or their engineer shall have full power and liberty to order and direct in writing any such alterations, additions, or omissions to be made, and that without in any way affecting or violating the contract, and the contractor shall, after receiving any such orders or directions, execute the works or such part thereof as may be affected by such order or direction in conformity therewith, and the difference of expense occasioned by the execution of any such order or direction shall be ascertained by the engineer, and the amount thereof shall be added to or deducted from the amount of the contract.

This would be acceptable in conjunction with an arbitration clause ; as it stands it should certainly be objected to.

The maintenance clause limits the responsibility of the contractor to three months, and is expressed in a form to which no objection can justly be taken. For the sake of engineers who may be desirous of making use of it in their own specifications, in conjunction with a complete arbitration clause, we insert it in full :—

The contractor shall keep the works in good and perfect repair and condition from the date when their completion shall have been certified by the engineer in writing, for the full period of *three calender months*, and the contract shall not be deemed completed until after the expiration of the said period, and if during such period any defects shall, in the opinion of the engineer, appear in such works, such defects, however caused, shall forthwith be made good by the contractor, at his own cost and charge, to the satisfaction of the engineer, so that the whole of the works may be delivered up at the end of the period of maintenance properly and completely finished, and perfect in all their parts in conformity in every respect with the terms of the contract. The contractor shall take the risk of, and be answerable for, any accidents or damage of whatever kind that may arise during the term of maintenance.

## THE CALCULATION OF DISTRIBUTING SYSTEMS OF ELECTRIC TRACTION UNDER BRITISH CONDITIONS.

By THOMAS TOMLINSON, B.E.

It seems to me that Mr. Sayers in his paper on this subject, read before the Institution of Electrical Engineers on the 3rd inst., was dealing with an actual case arising in practice, for which he desired to ascertain the appropriate system, and that the general deductions which he draws, other than those obvious from general considerations of the inevitable extra loss involved where electrical energy is generated in one form and transformed for use into another, were an afterthought.

It cannot obviously be contended that you can compare, generally, the relative value of systems of generation and distribution by a comparison of them in a particular case of demand which is favourable to any of the systems. Still less can you do so if you are tied to a site (or sites) for your power station which unduly favours or unfairly handicaps any of the systems, or if in the comparison you fail to credit each with the utmost flexibility and economy of which it is capable.

Now it is clear that demand for power in a long and narrow area (12 miles by 5 miles) favours two direct current stations

to be externally sheathed with lead.

to pass the tests, be unduly delayed, *the engineer may*, after seven



as against one direct current station, on the assumption, which the author makes, that the cost per unit at the switchboard is the same for two stations as for one; this could never be absolutely true, but might conceivably, with large stations and equal facilities for coaling, &c., be nearly true. It is also clear that the site, T, selected (or imposed), handicaps supply from one station by not being at the centre of the district; in fact, it is in a rather bad position for supply from one station, but in a rather good one for one of two supplying the given area; and, finally, to take the whole output of a power station at a site, T, actually on the line of trams, as generated as three-phase, and all subject to 15 per cent. loss in transformation, is scarcely giving sub-station working, from that site, a fair show; no man would, at the given site, consider this a possible practical alternative.

The method of working out the feeders, given in the paper, is a good one, especially on account of the ready moneying out of the losses and the simplicity with which it allows for the increased cost of boosted or transformed watts.

It would be very interesting to work out in this way the case of a single line—supposed level and evenly loaded with cars—running straight away from a power station, and to find the point at which it would be economical to feed the line from a sub-station, and how this point varied with the loading of the line.

Of course general deductions drawn from the mathematical solution of practical problems, under hypothetical conditions which do not obtain in practice, can only be rough guides at the best, and may be traps if rated above their proper value.

Mr. Sayers quite properly uses the Kelvin law of economy in calculating the current density in all these systems for the purpose of comparison, and doubtless in comparing sites and systems this should be done—it is like working from a datum point in levelling; but in the actual inception of an electrical engineering enterprise, it may be, and, I venture to say, nearly always is, neglected. There are two very good reasons why this should be so: first, the data are only approximate, and there is little use in working out copper sections to three places of decimals on doubtful data; second, even if the data were accurate, it would not, in general, be sound commercial engineering, which requires that you shall equip the enterprise at the lowest capital cost, which will ensure a fair dividend, and "Kelvinise" it afterwards with cheaper borrowed money.

As to the choice of site the author states, "The choice of a site for a generating station may greatly affect the generation costs, and as these materially influence the design of the distributing system, the importance of careful choice of site or sites is very great, and in any contemplated electric traction system this should be one of the earliest matters submitted to and decided by the engineer."

An obvious truism, neither worth saying nor repeating, if one had not seen it so often ignored in lighting systems.

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

### NEW PATENTS.—1900.

Compiled expressly for this journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

7,483. "Improvements in joints for rods carrying electric lamps and other purposes." H. Hirst and J. H. Collings. Dated April 23rd.

7,484. "Improvements in connections for electrical cables and kindred purposes." H. Hirst and M. Zellermayer. Dated April 23rd.

7,471. "Improvements in electric telegraphy." S. G. Brown. Dated April 23rd.

7,482. "Electric sweating mattress." I. Timar. Dated April 23rd.

7,510. "Improvements in electrically governed feeding and drinking appliance for animals, live stock, birds, and the like." C. Miles. Dated April 24th.

7,511. "Improvements in electrical time checking and registering apparatus." C. Miles. Dated April 24th.

7,513. "Improvements in secondary batteries." S. Cowper-Coles. Dated April 24th.

7,547. "Incandescent electric lamp." W. E. Irish. Dated April 24th.

7,561. "Improvements in maximum electric meters." The British Thomson-Houston Company, Limited. (H. O. Westendrap, United States.) Dated April 24th. (Complete.)

7,562. "Improvements in third rail insulators for electric railways." The British Thomson-Houston Company, Limited. (E. W. Rice, jun., United States.) Dated April 24th. (Complete.)

7,567. "Improvements in electric bonds for electrically connecting the meeting ends of two contiguous electric conductors." H. P. Brown. Dated April 24th. (Complete.)

7,593. "Improvements in contacts for incandescent electric lampholders, electric switches, and so forth." J. G. S. Lee. Dated April 24th.

7,606. "Improvements in electrical controlling switches." C. A. Lindstrom J. Hewitt, and T. Hewitt. Dated April 24th. (Complete.)

7,608. "Improvements connected with the production of electric light." E. Rasch. Dated April 24th.

7,609. "Improvements in glow lamps for high tension currents." P. Scharf Dated April 24th.

7,639. "Improvements in dynamo-electric machines." S. H. Holden and Chamberlain & Hookham, Limited. Dated April 25th.

7,645. "Improvements in distribution of polyphase currents." S. E. Fedden and W. Jamieson. Dated April 25th.

7,648. "Improvements in electric arc lamps." F. M. Long and E. Schnattner. Dated April 25th.

7,653. "Improvements in photographic papers, films, and plates for use in Röntgen or X ray photography." J. W. T. Cadett. Dated April 25th.

7,657. "Improvements in and connected with cord grips for electric lamp holders, ceiling roses, and the like." W. T. Burbey. Dated April 25th.

7,675. "Improvements in electrical time-distributing apparatus." H. H. Lake. (H. Cuénod, Switzerland.) Dated April 25th.

7,691. "Improvements in electrical work measuring instruments." G. W. Johnson. (Hartmann & Braun, Germany.) Dated April 25th.

7,695. "Improvements in wall plugs for electric lighting and heating." S. S. Galsworthy. Dated April 26th. (Complete.)

7,712. "Improvement in electric billiard marking time checking relating to the balls being out of play at the end of a stated time." M. Oliver. Dated April 26th.

7,721. "Adjustable bracket for electric lighting." P. Ludwig. Dated April 26th.

7,725. "Improvements in or connected with electric accumulators or storage batteries." A. G. Nesfield. Dated April 26th.

7,753. "Coupling for electric or other wires." R. Thompson and J. Dunphy. Dated April 26th.

7,759. "Improvements in electrically operated submarine working devices." L. Pauer and J. de Kutschera. Dated April 26th. (Complete.)

7,764. "Improvements in wire connectors." A. Gartner and C. H. McIntire. Dated April 26th.

7,768. "An improved negative accumulator electrode." E. W. Jungner. Dated April 26th. (Complete.)

7,777. "Improvements in apparatus for wireless telegraphy." G. Marconi and Marconi's Wireless Telegraph Company, Limited. Dated April 26th.

7,781. "Improvements in apparatus for wireless telegraphy." C. G. Robinson. Dated April 26th. (Complete.)

7,782. "Transmitting and receiving switch for wireless telegraphy." C. G. Robinson. Dated April 26th. (Complete.)

7,784. "Improved system of distribution and collection of current for electric traction." G. Davis. Dated April 27th.

7,792. "Improvements in electrically operated brakes for centrifugal drying machines or hydro extractors." H. C. Longsdon and S. Dale. Dated April 27th

7,795. "Improvements in electric light fittings." H. W. Calderbank. Dated April 27th.

7,805. "Method of and apparatus for utilising or converting wind force or pressure into electrical energy or work." J. K. Grinrod. Dated April 27th.

7,807. "Improvements in and relating to electrical switches and electrical accessories generally." G. W. Holt and A. J. Hallam. Dated April 27th.

7,851. "Improvements in and connected with electric incandescent lamps." O. Riebensahn. Dated April 27th.

7,861. "Improvements in or relating to electrical reciprocating apparatus." J. Brown. Dated April 27th.

7,881. "A direct-acting magnetic brake electric arc lamp." J. Lenderyon and T. S. M. Wyatt. Dated April 28th.

7,897. "Improvements in surface contact systems of electric traction." E. H. Tyler and A. G. Hansard. Dated April 28th.

7,941. "Improvements in electrical safety fuse apparatus." W. H. Beck. (H. Privat, Germany.) Dated April 28th.

## ELECTRICAL PATENTS OF 1886 EXPIRING IN MAY, 1900.

We are informed by W. P. Thompson & Co., that about 100 applications for electrical patents were filed in May, 1886. Of these some were never completed, and of those that were only six have been maintained to run their full term, viz., 14 years, and being of considerable interest, we give short abstracts of them below:—

**6,027. "Improvements in and apparatus for recording and reproducing speech and other sounds." J. Y. Johnson. (Volta Gramophone Company.)** Dated May 4th, 1886. Relates to graphophones. A record of speech or other sounds is produced by causing their vibrations to act on a cutting-style which engraves marks in a mass of soft solid material; the sounds may be afterwards reproduced by a thin reproducing-style caused to travel over the record. A suitable "tablet" or surface for engraving is a compound of beeswax and paraffin, which may in some cases form a coating on a foundation of paper or pasteboard. The groove formed in the tablet is made with sloping walls, and when the compound employed can be easily melted, it may be brought to incipient fusion by a suitable heating appliance before reproducing, in order to obtain as smooth a surface as possible for the reproducing style. For a similar purpose a brush is sometimes provided to sweep the record free of shaving, &c., in advance of the producer. The record may be formed on a "tablet" in the form of a disc, a paper strip, or a cylinder. 10 claims.

**6,042. "Improvements in and apparatus for reproducing sound from phonographic records." J. Y. Johnson. (Volta Gramophone Company.)** Dated May 4th, 1886. Relates to graphophones. Relates to means for reproducing sounds from records. The record (which is preferably cut in wax), is caused to act on a fluid (gas or liquid), to which it communicates vibrations corresponding to those originally impressed on it. The fluid may either be simply in contact with the record, or may be directed on it in the form of a jet. The vibrations thus produced may be rendered evident to the ear as sound in many ways. Forms of air and liquid jet reproducers are described, with mechanical and electrical means of rendering the sounds audible. 15 claims.

**6,047. "Improvements in and means, and apparatus for the reproduction of speech and other sounds by means of records." J. Y. Johnson. (Volta Gramophone Company.)** Dated May 4th, 1886. Graphophones. Relates to means for reproducing sounds from records. The record (which is preferably cut in wax) is first copied in iron or other magnetic material, and the speech or other sound is then reproduced from this copy. An electrotype is first taken from the original record in copper. The electrotype is mounted on a metal disc by means of plaster of paris; gear wheels and a hand wheel are provided. The disc is at one end of a shaft and an iron disc at the other. A spiral groove is cut in the iron disc, and the graving tool cuts the ridge between the convolutions of the groove. A slide is mounted on the frame and carries the graver in guides and the follower held in guides and pressing on the electrotype. The screw is tapped into the end of the follower and rests against the end of the graver; a spring presses the graver against the follower. Bevel gearing on the shaft works a screw tapped into a lug on the slide, thus drawing the slide forward through the requisite distance at each revolution of the discs. The magnetic record thus obtained is mounted on the shaft of a reproducing instrument. A needle forms the core of a coil with a telephone in circuit and

projects from one pole of a horse-shoe magnet towards the other pole; between the needle and the other pole the record revolves. Other electrical or mechanical means of reproducing may be employed. 16 claims.

**6,062. "Transmitting and recording sounds by means of radiant energy, and means and apparatus therefor." J. Y. Johnson. (Volta Gramaphone Company.)** Dated May 4th, 1886. A beam of light "or other radiant energy" is thrown into vibrations by means of a sensitive jet of fluid, and these vibrations are then photographically recorded. 24 claims.

**6,358. "An improved suspended lamp." D. L. Solomons.** Dated May 11th, 1886. Switches for incandescent lamps. The lamp is suspended by cords and counterweights, and its circuit is made or broken by pulling down or pushing up the lamp. For this purpose the motion of the lamp is caused to move a switch tongue into contact with a plate connected to the main lead. Or two suspending cords from the lamp leads and are uncovered at their upper parts; they then pass over metal insulated rollers connected to the main leads, and their lower parts are covered with insulating material to break the circuit when the lamp is pushed up. 3 claims.

**6,866. "Improvements in metallic telegraph poles and poles and posts for various purposes." J. C. Johnson.** Dated May 21st, 1886. Relates to the construction of tubular posts for various purposes, such as telegraph poles, signal posts, and flagstaffs. The post is constructed in two or more portions as required, of which the base is preferably a cast-iron tube with an internal shoulder upon which the upper part of the post rests. Above the shoulder the bore of the tube gradually tapers outwards, and at about the top 2 inches the tapering is more rapid. A strengthening ring is placed round the outer edge of the base, and a divided ring tapering externally is driven down round the tube into the tapering portion. Where the upper portion consists of more than one portion the parts are similarly joined. 1 claim.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

### 1898.

**10,616. "Improvements in enclosed arc lamps." C. Thomas-Davies.** Dated May 9th, 1898. Arc lamps are constructed to use carbons side by side and nearly parallel, the carbons and holders being situated in globes which are closed except where shafts carrying the holders turn in bearings formed in the metal tops of the globes. Otherwise the globe may be closed entirely, the carbon-holders carrying the armatures which are acted on through a thin porcelain or like plate covering the globe by an external electro-magnet, movement of the armatures being opposed by springs. In either construction the arc is kept at the ends of the carbons by a magnetic field existing between the convergent limbs of a long horse-shoe magnet. Two projections on this magnet maintain a stronger field near the carbon-holders to protect these. Each carbon-holder may carry two or more carbon rods, held together side by side, so that the arc passes to whichever carbon is longest. One carbon-holder is fixed on the base-plate; the other is carried by a horizontal shaft which passes through bearings in a cup, and carries arms supporting the cores of flat series and shunt solenoids, a balance weight and adjustment weight, and a dash-pot. The piston of this is carried by a counterweighted link on a fixed bracket. The magnet is wound in series with the carbons. In a modified arrangement both carbon-holders are supported by horizontal shafts, arms of which are linked to a large dash-pot movable vertically on a stationary piston by the U-shaped core of two vertical solenoids; the dash-pot, &c., are supported by two springs. In a different construction, one carbon is slightly inclined in a holder which forms an arm of the vertical shaft; this passes through a bearing in the top-plate of the globe, and has a curved arm carrying a U-shaped core in horizontal shunt solenoids, which tend to turn the shaft in opposition to a spring, and so to bring carbons together. The globe has a flange clamped between two rings. One ring is bored to fit a conical surface on the plate of the lamp, and is held against the surface by springs and eye bolts which engage lugs on the other ring. The springs form a safety valve for gases. In another arrangement the rings are screwed on to the base plate of the lamp, a flange on which enters a packed groove in the upper ring.

**12,268. "Improvements in insulating means for electric furnaces." W. L. Wise. (Aluminium Industrie Actien Gesellschaft.)** Dated May 31st, 1898. The walls are built of blocks of conducting material containing conduits for cooling fluids, and separated by non-conducting material which, being cooled by the conducting blocks, continues to insulate when the furnace is in operation. When the cooled product of the furnace is an insulator, the conducting blocks may be separated at first by air spaces, and the product allowed to accumulate in these spaces. The conducting blocks may be of various forms. 2 claims.

**12,313. "Improvements in secondary batteries or electric accumulators." F. King.** Dated June 1st, 1898. The surface of the active material has formed on it a number of projections in the shape of juxtaposed pyramids, the faces of which are equilateral triangles. 1 claim.

**12,325. "Improvements in apparatus employed in wireless telegraphy." G. Marconi and the Wireless Telegraph and Signal Company, Limited.** Dated June 1st, 1898. Relates to the class of apparatus described in Specification No. 12,039, A.D. 1896. The receiving apparatus, including the coherer with its trembler and choking coils, relay, batteries, and resistances, is enclosed in a metal case. The coherer and relay circuits are connected on one side to the metal case, which is put to earth by a wire. The other terminal of the coherer circuit is formed as a clip for engagement with a plug on the end of the flexible connection of the aerial conductor; this plug can be connected as desired to the transmitter circuit. The relay is connected to the recording-receiver by the case connection, and by a wire which passes insulatingly through the case to a chamber containing a coil of insulated wire sheathed with tin foil. 4 claims.

**12,326. "Improvements in apparatus employed in wireless telegraphy." G. Marconi and the Wireless Telegraph and Signal Company, Limited.** Dated June 1st, 1898. Relates to improvements in that class of apparatus described in Specification, No. 12,039, A.D. 1896. The coherer is connected to the secondary coil of a fine wire induction coil, the primary of which is connected between the aerial conductor and the earth or a capacity. A condenser is in series with the secondary and the coherer. The circuit of the local receiver is provided with choking coils, and forms a parallel circuit. Several forms of induction coil are described in which the primary is wound in parallel or series parallel sections, and the secondary is formed of one or more sections having decreasing numbers of turns in the several layers. Two forms of induction coil are also described, with parallel wires forming a single layer primary, and a single wire in one layer for the secondary. An extended wire netting may take the place of the aerial wire. 7 claims.

**12,438. "Apparatus for indicating leakages or escapes of current from electric conductors." Dr. M. Kallmann.** Dated June 2nd, 1898. The loss of current by leakage from a conductor to earth is measured by connecting to equal or known low resistances in series with it, at the ends of the part to be tested, and comparing the two falls of potential on these resistances. If necessary, another part of the circuit is connected to earth, through a lamp, to promote leakage on the part to be tested. The comparison may be effected by connecting the resistances through testing-wires to the two circuits of a differential galvanometer, or by connecting them to two pairs of high resistances, the middle points of which are connected by a galvanometer. If the resistances are all equal, or have fixed ratios, the deflection of the galvanometer measures the leakage from the conductor; otherwise the resistances may be adjusted until no current passes through the galvanometer, and the leakage calculated from their ratios. The galvanometer may have a contact device, to indicate automatically the occurrence of leakage. For measuring leakage from rails on an electric railway, the resistances may be parts of rails. The conductor may include the whole of a system of lamps, &c., to be tested for leakage, either with or without the mains supplying it. On a three-wire system of lamps, &c., three low resistances are inserted in the three supply wires, and connected by three pairs of high resistances to the terminals of one galvanometer. 5 claims.

**12,471. "Improvements in electrically-propelled motor cars." L. Coulet.** Dated June 3rd, 1898. Upon the vehicle is mounted a generating dynamo actuated by any suitable motor. This dynamo enables current to be supplied to accumulators either continuously or intermittently. The advantage of this system is that the motor need only be capable of producing the average power required, variations in the tractive power being effected by the electrical system. 1 claim.

**12,511. "Improvements in or relating to incandescent electric lamps." G. Riebensahm, J. Pleichati, H. Friedeberg, and E. Kruger.** Dated June 3rd, 1898. Incandescent lamps. A cylindrical lamp is held in a socket by a wire helix, or otherwise, and is surrounded by an ornamental outer globe which is secured detachably by a bayonet joint or a screw or otherwise, for advertising or decorative purposes. 2 claims.

**12,667. "An improved device for fitting reflectors, shades, globes, or the like to electric incandescent and other lamps." C. Bartenstein.** Dated June 6th, 1898. Globe, reflector, or shade holders, applicable more especially to electric incandescent lamps. The holder consists of a sleeve adapted to fit on the lamp and flanged to carry the globe. The sleeve may be slit, to grip the lamp and slotted to pass bayonet-joint pins thereon. The globe is fixed by a ring, which screws on the sleeve or is secured thereto by a bayonet-joint or otherwise. In a modified form the sleeve is flanged or flared to fit in the curved neck of the globe and tongues are cut and bent over on the edge of the neck; rings may be interposed, as shown. 3 claims.

**12,763. "Improvements in and relating to apparatus for electro-therapeutic purposes." W. P. Thompson. (Prof. Dr. A. Maggiorani.)** Dated June 7th, 1898. Electricity, administering; electric baths. The invention relates to apparatus which may be employed for baths, for fomentations, and for other applications in the dry way. The plates of the battery are suspended by means of a wire from a drum so that their immersion, which is indicated on a dial, may be regulated as desired. In a shunt circuit is placed an ampere-meter consisting of an electric bell the coils of which are adjustable to and from the armature and are provided with a pointer working over a scale graduated in amperes; the bell will not ring until the current indicated by the pointer is attained. The induction coil is formed with the secondary coil adjustable on the base which is provided with a graduated scale; the centre portion of the cone consists of a bundle of soft iron wires movable longitudinally. The conducting wires are formed of alloys of aluminium, phosphor bronze, or nickel. The induction coil is connected to terminals in the form of pins, balls, rollers, and the like placed upon the body of the patient or to terminals in a bath. 2 claims.

**12,765. "Improvements in or relating to the electrolysis of liquids and apparatus therefor." W. P. Thompson. (M. Hazard-Flamand.)** Dated June 7th, 1898. Relates to apparatus for the electrolysis of liquids to obtain the two gases given off at the two electrodes without admixture, the gases particularly mentioned being oxygen and hydrogen. An outer metal vessel forms the negative electrode and is provided with an outer channel, and with inner vertical partitions. Both the partitions and the vessel itself have projecting ribs. If the vessel is made of insulating material, suitable plates must be used as cathodes. Each anode having ribs is supported by a conducting bar enclosed in a bell having a paraffin joint. The bell is itself enclosed in an open cylindrical vessel formed in one with the lid, and filled with paraffin oil to form an hydraulic joint. The lid has a depending rim dipping into the gutter which contains an insulating liquid. Between the anodes and cathodes are diaphragms so constructed as to lead away the two gases evolved separately. The diaphragms are built up of a number of annular troughs which contain the electrolyte, and have depending strips dipping into the trough below, the lowest one dipping into an insulating dish. The diaphragms are supported at each end of the vessel. The highest trough has a deep channel into which dip the lower ends of walls formed in one with the cover. The gases evolved from the anode and cathode are thus kept separate, and are led away to different outlets. If the liquid, which for obtaining oxygen and hydrogen is preferably a conducting solution of an alkali, such as soda or potash, is allowed to run short, the gases evolved near the top of the vessel can pass through perforations, and bubbling through the oil in the cylinder escape to the atmosphere, the bubbling calling attention to the want of further electrolyte. 3 claims.

**12,774. "Improvements in electric railways on a sectional conductor system." G. F. Redfern.** Dated June 7th, 1898. The working conductors and the rails are in sections connected through a switch contact on an oscillating shaft to the main supply and return conductors. This shaft, weighted to return to the off position, carries an armature lying between pole-pieces attached to the sectional conductors which are magnetised by electro-magnets on the vehicle. The appliance is contained in a road box with a removable cover and an inner box enclosing the switch. The rail sections may be longer than the supply sections, or they may be continuous to act as the return. 9 claims.

**12,810. "Magnetic measuring instruments." J. Russell.** Dated June 8th, 1898. Relates to a magnetic balance for measuring the properties of iron or other metals. Two strips of iron to be tested are secured by non-magnetic springs, and stops in channelled supports, which are placed in two stationary solenoids. Between these is a third solenoid, carried by a counter-weighted beam, which is suspended and supplied with current by wires. The beam carries a parallel divided scale, with a movable rider. The three solenoids are connected in series, and supplied with current so that both strips tend to raise the solenoid magnetically; this tendency is balanced and measured by the rider. The measurement may be repeated with different currents. Two different strips of metal may be compared by reversing the connections of one of the solenoids, so that only the difference in their effects acts on the movable solenoid. In modifications, the solenoid on the beam may be replaced by a permanent magnet, or by one of the two specimens of metal, in which latter case it is surrounded by one of the two stationary solenoids, the solenoid on the beam being dispensed with, and the attraction or repulsion between the two metal strips measured; the beam and both strips may be within one solenoid. Otherwise the strip on the beam may be situated between two parallel stationary strips of different metals, in one solenoid. The beam may be supported centrally, and carry a strip at each end, four or six solenoids being used. The instruments may be arranged to use torsion wires or springs. The instrument may be used for direct measurements of hysteresis, by supplying the solenoids with an alternating current in quadrature with another current supplied to the other solenoid from a generator or revolving commutator, or by the use of inductances and resistances in the circuits. 1 claim.

**12,839. "Improvements in electric glow lamp fittings." Siemens Brothers & Co., Limited. (Siemens & Halske Aktien Gesellschaft.)** Dated June 8th, 1898. Incandescent lamps, connecting caps, &c. The bulb neck is made with two depressions or projections at opposite sides, to engage corresponding parts of a cap. The cap is slit near the projections or recesses, to permit it to be sprung on to the neck, and may be further secured by placing a spring ring on it. 2 claims.

**12,840. "Improvements in electric glow lamps." Siemens Brothers & Co., Limited. (Siemens & Halske Aktien Gesellschaft.)** Dated June 8th, 1898. Incandescent lamps, connecting caps to. The bulb neck is made of oval or oblong section, with recesses or projections in its greatest diameter to engage corresponding parts of a cap. The cap is of circular section, but is compressed laterally when it is being placed on the bulb; when released it reassumes its circular form, with the projections in engagements. The cap may be slit, and may be secured by hooks, solder, or otherwise in an outer ring. 1 claim.

**26,033. "Improvements in connectors for electrical cables or wires." H. W. Miller.** Dated December 9th, 1898. Relates to a means for connecting cables or wires, a socket is made of sheet metal having tongues projecting from each side of one end of the socket. These tongues are bent round the cable to which connection is to be made. 2 claims.